THE OHIO JOURNAL OF SCIENCE

VOLUME XXXIII — 1933

LAURENCE H. SNYDER, Editor-in-Chief

PUBLISHED AT COLUMBUS, OHIO, BY THE

OHIO STATE UNIVERSITY

and the

OHIO ACADEMY OF SCIENCE

THE OHIO JOURNAL OF SCIENCE

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THE OHIO JOURNAL OF SCIENCE

VOL. XXXIII JANUARY, 1933 No. 1

ABUNDANCE AND CONSERVATION OF THE BOB-WHITE IN OHIO.*

S. CHARLES KENDEIGH.

INTRODUCTION.

Ever since the eastern bob-white or quail, *Colinus virginianus virginianus* (Linnaeus), was put on the protected "song-bird list" in Ohio in 1917, after annually closed hunting seasons since 1913, there has been considerable discussion and agitation among sportsmen to have it recognized again as a game bird. Frequent attempts to introduce legislation in the Ohio Assembly, for having an open hunting season again put on the species, have been frustrated up to the present. The question has caused so much feeling between factions that a permanent settlement to the satisfaction of both sides of the controversy is very desirable, if it prove practicable. It is hoped that the present paper will contribute towards that end.

ESTHETIC AND ECONOMIC IMPORTANCE.

The bob-white is a very attractive and beautiful bird with a loud cheery song, and has endeared itself to all lovers of nature and to country folk in general. Many urge the complete protection of the species in the State on this basis alone.

The intelligent farmer has good reason to wish that the species be maintained in its normal numbers. The studies of Judd (1903, 1905), Nice (1910), and others show beyond doubt that the bird has great value as a destroyer of weed seeds and insects. Some 60 different species of weed seeds and 116 species of insects are consumed as food. Among the insects occur such distinctly undesirable forms as chinch bug, potato beetle, and striped cucumber beetle. The species consumes some grain, but this seems to be largely waste grain that remains after the crop has been harvested.

*Contribution from the Baldwin Bird Research Laboratory (No. 25) and Western Reserve University, Cleveland, Ohio.

IMPORTANCE AS A GAME BIRD.

The bob-white undoubtedly makes a fine game species in areas where it is sufficiently abundant. The hunting of bob-white is a sport of high order, since it demands skill, training, and patience, and requires a hardiness and love of the out-of-doors that may well be encouraged.

BASIS FOR CONSERVATION.

The above discussion shows that the bob-white is of legitimate interest to the lovers of nature, to the farmer, and to the sportsman. Can conservation of this species be based upon measures that will permit the realization of all these interests? This realization is possible only if the greatest care be taken to consider the safety of the bird as a species and the maintenance of a large number of individuals all over the State. One of the first studies that needs to be made in this connection is the determination of the actual population of the bird and the factors that are responsible for increasing and decreasing its numbers.

CENSUS-TAKING.

Since 1901, there have been reported annually in *Bird-Lore* magazine the results of one-day censuses of all species of birds, taken between December 22 and 27 by observers located all over the country. Since 1908 the number of census reports from Ohio have been sufficient to make possible some estimation of the number of bob-white present during this time of the year. These records have been compiled for the years 1908 to 1931, inclusive, with the results shown in Table I.

In arriving at an estimation for the total population of bob-white in Ohio, various factors must be considered. The total number of reports for different localities is not so important as the number of parties making these reports. It is necessary, in order to judge the amount of territory that was covered in the census, to determine the average number of miles traveled by each party per hour in the field for each year separately. A difficulty arises as to the width of this strip of territory over which the census-taker could have made an accurate count of the bob-white present. With some hesitation, this was estimated to be about 75 feet. Using this figure and knowing the average mileage covered per hour, the square mileage of

territory covered could be figured. A correction of this figure must next be made for the number of people making up the party. The average number of people per party ranged from 1.2 in 1908 to 2.4 in 1931. It is assumed that two people in a party will be approximately twice as efficient in making a census of bob-white as will one. This may not be strictly true in some cases, but seems to be the only legitimate way,

TABLE I.

TOTAL POPULATIONS OF BOB-WHITE IN OHIO DURING LAST 24 YEARS, ESTIMATED FROM BIRD-LORE CHRISTMAS CENSUS REPORTS.

Year	Total Number of Parties Reporting	Total Populations, Uncorrected	Total Populations, Corrected from Figure 1
1908	15	1,343,000	1,700,000
1909	10	814,000	600,000
1910	16	1,800,000	1,350,000
1911	21	1,128,000	1,500,000
1912	24	521,000	900,000
1913	12	345,000	650,000
1914	16	1,710,000	950,000
1915	16	349,000	1,200,000
1916	12	2,395,000	1,500,000
1917	11	369,000	1,000,000
1918	8	592,000	1,000,000
1919	14	2,706,000	1,800,000
1920	16	1,350,000	2,600,000
1921	17	2,549,000	3,500,000
1922	23	5,496,000	4,000,000
1923	16	2,506,000	4,100,000
1924	19	5,740,000	4,100,000
1925	24	5,008,000	3,700,000
1926	26	2,369,000	3,100,000
1927	34	3,561,000	2,500,000
1928	27	997,000	2,000,000
1929	33	3,018,000	2,000,000
1930	44	3,553,000	2,550,000
1931	42	2,307,000	3,350,000

without careful field tests, in which a correction may be made for the size of the party. The square mileage of territory covered per party is multiplied, therefore, by the average number of people constituting the parties during that year. Knowing the total square mileage in the State, the percentage of this area covered by a party of census-takers during an hour can then be determined.

The next step in this computation consists in figuring for each year separately the average number of bob-white seen

per party per hour in the field. When this is known, and the percentage of the total area of the State that is covered is known, the total population of bob-white may be readily computed. These are the figures given in Table I.

In this method of computation the attempt is made to eliminate, as far as possible, errors dependent upon variations in the human equation. Census-takers undoubtedly select their routes in order to get the largest possible number of birds of all species. Such a route may be at times through habitats where bob-white are most abundant, as along fences, hedge-rows, forest edges, etc.; but at other times this route will traverse woods, village streets, and other localities ill-adapted for bob-white. As areas unfavorable for birds of all

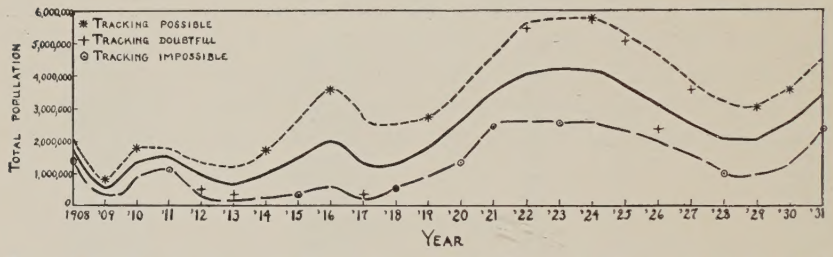

FIGURE 1. FLUCTUATIONS IN ABUNDANCE OF BOB-WHITE IN OHIO FROM 1908 TO 1931. The asterisk marks years with sufficient snow on ground to make tracking of birds possible; the cross marks years when the ground was only partially or lightly covered with snow so that tracking may or may not have been possible; and the circle marks years when the ground was bare so that tracking was impossible. Broken lines connect years when tracking was possible and years when tracking was impossible. The full continuous line represents the median and probably most accurate estimation of the total annual populations.*

species, including the bob-white, are generally avoided, estimates of total bob-white population based on these censuses will tend to be high. This is counteracted in part by the fact that census-takers do not use trained bird dogs, so that some bob-white in the most favorable places are undoubtedly missed. By giving each census-taker credit for covering a rather broad area of 75 feet on his trips, even when two or more persons take the census together, it is believed that the unfavorable "blank" spaces are accounted for.

Another possible source of error in these figures of total population lies in the effect which the weather on the day that the censuses were taken has on the number of bob-white

*An error in the population data for 1916, found when reading proof, is corrected in Table I.

recorded. A compilation was therefore made of temperature, cloudiness, wind, precipitation, and amount of snow on the ground on the days that the censuses were taken. None of these factors except the last appeared to affect the numbers of bob-white recorded. In a personal communication, Stoddard emphasized the importance which the amount of snow on the ground may have on the records obtained. When the ground is covered with snow, tracks of the bird may be readily found and easily followed so that it is logical to expect a larger number of birds to be recorded during those years than during years when the ground is bare. The importance of this factor is shown in Figure 1.

The actual figures of total bob-white population, as determined by the methods above described, were first plotted in Figure 1. Then the years were marked according to whether tracking was possible, doubtful, or impossible. The figure then showed clearly that many more birds were recorded during years with snow on the ground than during years when the ground was bare. A line was then drawn connecting the figures for those years with snow and another line connecting the figures for the years without snow. In general, the trends in fluctuation of population are very similar regardless of which curve is taken. Finally, a medium curve was drawn halfway between the other two. Probably this more nearly represents the actual total bird population in the State than does either of the two extremes. The corrected total population given in Table I are figures read from this medium curve in Figure 1 for the corresponding years. We would judge these figures to be accurate to within 25%, but whether or not they are this accurate must wait and be checked in the future by intensive field work over corresponding years. The *Bird-Lore* censuses are admittedly not all that might be desired to serve as a basis for an estimation of total population of birds, but furnish the only information available for the past two dozen years.

AVERAGE ABUNDANCE.

The average abundance of the bob-white in Ohio during the last 24 years is 2,152,000 birds, or one bird to approximately 12 acres. Since the species has been given continuous protection since 1913, the average abundance of the species may be figured from 1913 to 1931, inclusive. This is 2,400,000 birds, or one bird to 10.9 acres. The greatest abundance which is

recorded for the species during any year in this 24-year period is 4,100,000 in 1923 and again in 1924. This is one bird to 6.4 acres. The number of birds per acre would average higher if only agricultural land with favorable habitats were included instead of taking the whole area of the State. Undoubtedly also, the species varies in abundance locally in different parts of the State, being less abundant in some regions and more abundant in others.

Leopold (1931) found that one bird on two to four acres of farming land is the most frequent density of population in the north central states, with one bird on four to eight acres ranking a close second. One bird per acre is believed to be the "saturation" point of greatest possible abundance of bob-white. In "natural" areas of Florida, Stoddard (1931) found one bird on four to five acres. Likewise, on many preserves in southern Georgia, Stoddard found only one bird on four to five acres, while on others he found one bird on two acres, and on the best developed acres, one bird per acre.

FLUCTUATIONS IN ABUNDANCE.

In southern Georgia, Stoddard (1931) found that the bob-white population was essentially stable from year to year with no evidence of regular cyclic fluctuation in numbers. Variations of abundance occurred, but never exceeded 50%. The rather stable nature of the bob-white population in the south may be due, in part, to the absence of severe winter weather, particularly to the absence of snow.

Leopold (1931) has discussed in detail the abundance of bob-white in Minnesota, Wisconsin, Michigan, Iowa, Missouri, Illinois, Indiana, and Ohio. He likewise states that the quail population is very stable except along the very northern borders of the species' range. The recollections of local sportsmen, which Leopold compiled, show low numbers of birds in parts of Ohio in 1887, 1891, 1901, 1923, and 1928, and all over Ohio in 1918. The average interval between these seven known periods of scarcity is seven years in Ohio. In nearby states the period ran from four to seven years.

The curve of abundance of bob-white in Ohio based on the *Bird-Lore* census reports (Figure 1) shows low points in 1909, 1913, 1917–1918, and 1928–1929. The low point of 1909 is not well established, since it is based on records of only one year. This agrees with the findings of Leopold for low numbers

of birds in Ohio in 1918 and 1928, but does not agree with his report of low numbers in 1923, when this curve reaches its highest point.

Figure 1 shows that the bob-white reached peaks of abundance in 1911, 1916, and 1922–1924. The species was more abundant in 1922–1924 than in either of the other two peaks.

The time intervals between the low points in the curve of abundance are approximately 4, 4½, and 11 years, respectively. The time intervals between the peaks of abundance are approximately 5 and 7 years, respectively. This evidence is not sufficient to indicate that there are definite cycles in the abundance of the bob-white but does show that considerable fluctuations in abundance occur.

INBREEDING AND OUTBREEDING.

There is a widespread opinion among sportsmen that bob-white will decrease in size, vigor, and abundance through inbreeding, if the coveys are not scattered by shooting. In contradiction to this idea are the statements of some of the leading students of bob-white in America. Leopold (1931, page 54) states, "In short, there is not a shred of real evidence that quail inbreed if unshot, or that it would hurt them if they did." People apparently forget that the bob-white existed and thrived for ages before the advent of the white man and the shot-gun without ill effects resulting.

Stoddard (1931) has studied the question of inbreeding in bob-white. He states that hunting does increase, to some extent, the shifting of birds from one covey to another, but that the increased shifting due to this cause is not so much as might be expected, nor is the shifting and intermingling of birds from one covey to another dependent on hunting. There is some tendency for mating in the spring to take place between members of the same covey, but the covey is not a family group. The covey is made up of members of several different broods and of surplus cocks and unattached individuals. He found, through banding operations, that there is a shuffling of birds between coveys before mating begins regardless of whether or not there is hunting.

Dr. Baldwin, of our laboratory, is positive in stating that shooting does not break up coveys of bob-white as long as a sufficient nucleus of birds remains. Dr. Baldwin has spent

considerable time in the field in southern Georgia during the last thirty years, and was, in fact, responsible in large measure for organizing the Quail Investigation there under the able leadership of Mr. H. L. Stoddard. He makes this comment upon the subject of breaking up coveys and inbreeding:

"A number of the sportsmen, subscribers to the Quail Investigation, were either near friends of mine or members of my family, so that during each winter season I made many trips with them into the quail fields shooting with gun or camera. Most often I went with a nephew who had some fifteen thousand acres of quail fields and had been accustomed for many years to take about 1,000 quail each year from that area. His game keeper, Jim, was famous in that part of Georgia for his knowledge of the game and his ability to know each covey of birds in this entire area and, at will, to locate the covey and remember the exact number of birds in the covey. It was the daily experience to plan with Jim just what portion of the fields would be hunted for that day, and just what coveys would be gotten up. Jim would tell with extraordinary accuracy just how many birds were left in a certain covey when it was last shot out, and when the covey was flushed that number of birds would get up; or at times if birds were missing, it was judged and sometimes afterwards proven that poachers had been into the covey. So accurate were these observations as to number of birds, and so well could the numbers be traced throughout the winter that it was preposterous to say that coveys were broken up by shooting. Indeed this old tradition about breaking up coveys by shooting to prevent inbreeding was discussed and at times we would get up coveys on succeeding days on purpose to note that the numbers closely tallied with the number of birds left when last shot out. One who remains in the vicinity for a few hours after the covey is shot out will see the birds gather into a covey again, and usually no bird has been driven so far as into the territory of the next covey. The tradition that the health of the birds is improved by breaking up coveys in order to prevent inbreeding is subject to fatal criticisms."

East and Jones (1919) have discussed in detail the genetics of inbreeding and outbreeding among all sorts of animals and plants. They maintain that inbreeding in itself is not deteriorating to a race, but that it may weed out undesirable characteristics that ordinarily lie hidden in the genetic constitution of individuals. Such weeding out of the strains of weakness in a race may be desirable, as it leaves the remaining stock more uniform and healthy. This is the way that thoroughbred domestic stock has been originated and improved.

From these various studies, we may infer that if inbreeding were to occur in the bob-white population, there may be, at first a slight decrease in numbers due to the elimination of

individuals having unfavorable combinations of genetic characteristics, but that this would be followed by an increase and building up of a more healthy and vigorous stock. However, the striking fact is that there is no evidence that inbreeding occurs in the bob-white, nor that it is an important factor for consideration.

CAUSES OF FLUCTUATIONS IN ABUNDANCE.

Any one of several factors may be responsible in causing fluctuations in the number of birds. In the case of the bob-white, four factors have been singled out as of probable importance, namely, change in habitat (cover), occurrence of epidemic diseases, fluctuations in available food, and variations in climate. These factors may vary independently, but they produce a greater effect upon the bird when they combine and interact.

Leopold (1931) has stressed the great importance of cover to birds in the north-central states. Cover suitable for bob-white was much more abundant in the past than it is now, and he correlates this with a greater abundance of the species during the 19th century. Information is not available, however, to permit correlation between changes in cover and variations in abundance of the bird from one year to the next.

There is always the possibility that disease may be the active agent causing fluctuations in the abundance of a bird, although Stoddard (1931) found little evidence that disease was important with the bob-white in southern Georgia. Lack of food or the occurrence of severe weather may reduce the resistance of a bird to disease so that it may then become important.

During ordinary years there appears to be plenty of food available for the bob-white at all seasons, although late winter is a critical period. The bob-white selects its food from that which is most abundant, and, when it is able to find an adequate supply, is able to maintain its resistance and vitality (Errington, 1931, 1930).

The climatic factors which appear to be of particular importance are winter snowfall, summer rain, and temperature. Errington (1930, 1931) found that the bob-white is able to resist extremely low temperatures as long as food is available, but when snow covers the food supply, disaster results. Sleet storms and ice would have the same effect as snow in rendering

food unavailable. In our own studies with passeriform species (Baldwin and Kendeigh, 1932), we found that lack of food reduces a bird's resistance so that temperatures that are not exceptionally low become destructive. In discussing the mortality of bob-white, Leopold (1931) states that winter losses predominate in the northern tier of states and nesting losses in the southern. He believes that there is a direct killing of bob-white by climatic forces during severe winters, and that hard rains are destructive during the nesting season,

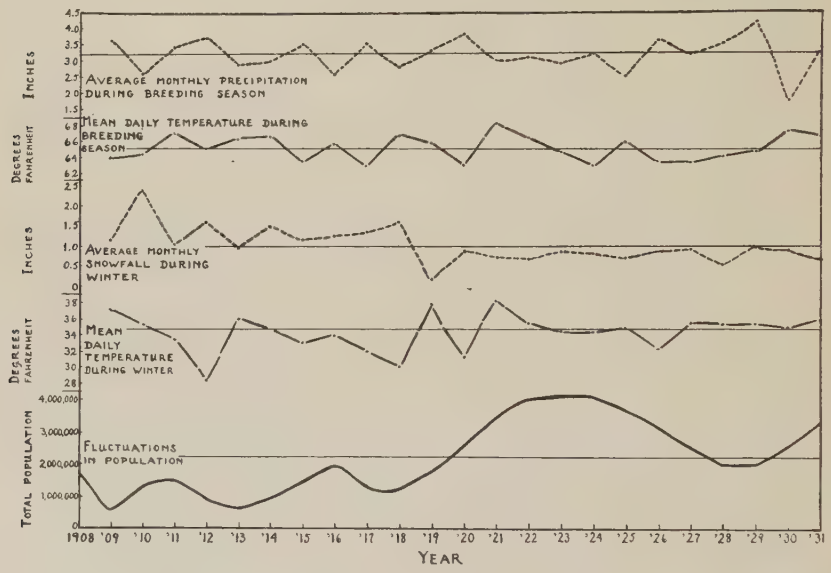
INCHES
AVERAGE MONTHLY PRECIPITATION DURING BREEDING SEASON
DEGREES FAHRENHEIT
MEAN DAILY TEMPERATURE DURING BREEDING SEASON
INCHES
AVERAGE MONTHLY SNOWFALL DURING WINTER
DEGREES FAHRENHEIT
MEAN DAILY TEMPERATURE DURING WINTER
TOTAL POPULATION
FLUCTUATIONS IN POPULATION
1908 '09 '10 '11 '12 '13 '14 '15 '16 '17 '18 '19 '20 '21 '22 '23 '24 '25 '26 '27 '28 '29 '30 '31
YEAR

FIGURE 2. CORRELATION BETWEEN FLUCTUATIONS IN ABUNDANCE OF BOB-WHITE AND CLIMATIC FACTORS. The climatic factors considered here are average monthly precipitation and mean daily temperature during the breeding season (April, May, June, July, and August) and average monthly snowfall and mean daily temperature during the winter (November, December, January, February, and March). The narrow straight medium line running through each curve is the average value for the 23-year period (1909–1931).

particularly to young birds. Stoddard (1931) found that reproduction is usually higher and nesting mortality lower during dry seasons than during wet ones. Severe droughts are, however, unfavorable in Georgia because they reduce the percentage of eggs that hatch in nests that are placed on the hot parched ground.

With these points in mind, an attempt was made to correlate the fluctuations noted in the abundance of the bob-

white in Ohio with snowfall, summer precipitation, and mean temperature. The climatic data were compiled and averaged for the following localities from the Monthly Weather Review of the U. S. Weather Bureau: Cincinnati, Columbus, Dayton, Cleveland, Sandusky, and Toledo. In Figure 2, the average monthly snowfall and the mean daily temperature during the five winter months of November, December, January, February, and March, and the average monthly precipitation and mean daily temperature during April, May, June, July, and August are shown together with the curve of abundance of the bob-white. The effect of temporary periods of severe weather, lasting for a few days only, have not been analyzed in this paper.

The major point of significance in the curve of total annual populations (Figure 2) is the much greater abundance of the bob-white from 1919 to 1931 than from 1909 to 1918. An analysis of the curves for the four climatic factors indicates that this difference in the abundance of bob-white is most significantly correlated with a greater snowfall and a lower temperature during the winter for the earlier period. During the winter months from 1909 to 1918, inclusive, the snowfall averaged 1.41 inches per month compared with 0.76 inches per month from 1919 to 1931. The mean daily temperature during the winter was 33.6° F. for the earlier period and 35.0° F. for the latter. Since the species was given continuous protection from hunting beginning in 1913, this factor was not responsible for determining the lower numbers during the earlier period, although it may have been a contributing factor during the first four years.

The dip in the population curve during 1912–1913 is correlated with unusually severe conditions in 1912, when winter temperature was very low, snowfall high, and, in addition, heavy precipitation occurred during the breeding season. In 1913, climatic conditions ameliorated considerably, but this was not marked by an increase in number of birds. Apparently, other factors came into play this year which our data do not bring out.

The dip in the curve of bob-white abundance in 1917–1918 is correlated with falling winter temperature and increasing amount of snowfall becoming particularly severe during the latter year. Heavy precipitation and low temperature prevailed during the breeding season of 1917, but improved in 1918.

The last big depression in the abundance curve, beginning in 1925 or 1926 and culminating in 1929, is not correlated in these data with severe winter conditions but appears to be most significantly related with high precipitation during the summer season, this being combined with summer temperatures persistently lower than normal.

The rise in the curve of bob-white populations in 1910–1911 is not marked by particularly favorable climatic conditions. Snowfall was heavier in 1910 than in any other year, but this was apparently compensated for by the high average temperature which prevailed. The winter of 1911 had less snow, but the temperature averaged lower. It may well be that neither heavy snowfall nor low temperature during the winter is particularly effective in reducing the number of bob-white except when these conditions occur together. This they did during the following year of 1912, and then there appeared a decrease in birds.

There is little to mark the years of 1915 and 1916 when an increase in bob-white is noted. Climatic conditions were not particularly favorable nor markedly severe. The closing of the hunting season for bob-white during these years may well be responsible for the increase in numbers of birds noted.

The long upward trend in abundance of bob-white reaching the peak numbers in 1923 and 1924 was given a good impetus in 1919 by unusually favorable winter conditions and moderate breeding ones. During 1920, the climate was less favorable. The winter was cold, although the amount of snow was very moderate. During the summer, low temperatures were combined with heavy precipitation. It is quite possible that a minor fluctuation in abundance occurred this year, but does not show in our data. The following year, 1921, was again very favorable climatically, probably one of the best during the entire 24-year period. The following four years were moderate.

The long downward trend in abundance of bob-white beginning in 1925 was stopped abruptly and given an upward curve again in 1930. This latter year was marked by a moderate winter and a warm, very dry summer. The upward trend in numbers persisted in 1931, and there is every reason to suppose that it was again augmented in 1932.

Summarizing the correlations between climate and population trends in the bob-white that have been noted, it appears

that severe winters marked by low temperatures combined with heavy snows are generally disastrous to the species and will greatly reduce it in numbers. Unfavorable climate during the breeding season, i. e., heavy rains and low temperatures, acts less precipitously upon the numbers of birds, but will reduce the population by affecting the amount of reproduction.

It is worthwhile to note here that the positive correlation that has been made between climate and trends in population of bob-white not only brings out the importance that climate has in affecting the numbers of birds but also substantiates, to some extent at least, the general fluctuations noted in the population trends themselves.

MORTALITY.

Errington (1930, 1931), who has kept large numbers of coveys under observation throughout winter seasons, found a mortality of less than 7% during one winter that was mild and almost snowless. During another winter, he found a mortality of 30%, as a consequence of severe cold and heavy snow during January.

As the result of the severe winter of 1912 followed by a none too favorable breeding period, there was a decrease of 40% in the bob-white population of Ohio. In 1917 and 1918, cold, snowy winters were followed in 1917 by unfavorable climate during the breeding season but by favorable climate during the breeding season of 1918. This corresponds with a decrease in population of birds amounting to 33% over what it was in 1916. The winter of 1918 was more severe than in 1917, but this was apparently offset by a more favorable breeding period.

During what appears to have been moderate winters but unfavorable breeding periods from 1926 to 1929, inclusive, there was an average decrease in total population of 14% per year. This means that the reproduction of the species during these years enabled it to compensate very little if any for the normal rate of mortality of the old birds even during years when the old birds were not subjected to particularly severe winter conditions.

RECUPERATIVE POWERS.

The reproduction of bob-white must fully compensate for the annual rate of mortality of adult birds even during favorable years, if the population is to remain constant. If an

increase is to occur in the number of individuals, not only must this be done, but also a surplus of young must be raised. During the 12 years in this record when an increase in population was noted, this surplus has amounted, on the average, to 39% of the previous year's numbers. If the figure of 14%, given above, be assumed as representing somewhere near the normal rate of dying off of adult birds under favorable climatic conditions, then the total recuperative powers of the bob-white under favorable breeding conditions would be approximately 53%. In other words, a pair of adult bob-white is able to raise about one bird to maturity, on the average, during favorable years. This figure needs to be checked by more intensive field study, but furnishes a preliminary figure with which to work. An unfavorable year, therefore, that causes a loss of birds amounting to 33–40% of the previous number will not be fully compensated for until the second favorable season for reproduction.

METHODS FOR INCREASING ABUNDANCE.

The bob-white is not so abundant as is desirable if the greatest possible benefit is to be derived from its presence in the State. After severe winters or unfavorable breeding seasons the species may be very scarce. How may the number of bob-white in the State be increased?

The devastating action of severe winter weather may be mitigated locally by providing food artificially. Errington (1930, 1931) recommends the leaving of isolated shocks of corn near favorable habitats of bob-white. The artificial feeding of the entire population throughout the State during unfavorable years seems impractical, without the ardent and enthusiastic co-operation of the entire farming population. This will require considerable in the way of an educational policy. The farmer holds the control in all measures that are designed to permanently increase the number of bob-white, and unless his co-operation is solicited, all these measures of conservation will fail.

Leopold (1931) is working on a method of game management in states where hunting is permitted. He suggests that the farmer consider the natural breeding and protection of bob-white on his farm as a crop to be actively encouraged, and that remuneration be sought from levies on sportsmen who desire to hunt on his property.

For increasing the population of bob-white, the maintenance

of a proper habitat for shelter and food is an absolute prerequisite. Unless food is available in abundance at all seasons of the year with the proper shelter from enemies, any artificial means of multiplying the number of bob-white is futile. If the proper habitat is available or can be increased in extent, the bob-white will ordinarily increase in abundance on its own natural resources until the saturation point is reached.

The natural habitat of the bob-white consists of open woods, with plenty of shrubs and grass, shrubby and grassy fields, fallow fields, shrubby fence rows, and thickets adjacent to open land. Such habitats could be readily encouraged by farmers if the desirability of doing so were effectively brought to their attention. The bob-white must have suitable cover to furnish it with shelter from enemies, shelter from climatic elements, and as a location for placing and hiding the nest. The bird seldom wanders far from shelter of some sort. The flight of the bird is swift and powerful for short distances but cannot be maintained for long, so that shelter must be available within easy reach or the bird will be exposed to the attack of many predators. This cover can be created by the farmer with little or no loss to normal operations. Osage-orange hedge-rows are very favorable, or, if these are not practical, the allowing of wild shrubbery and briars to develop along fence rows, fence corners, farm lanes, or other out-of-the-way places will well serve the purpose. If semi-open woodlots, river bottoms, hilly areas, or other areas unsuitable for crops are available, the bob-white will flourish if the natural growth of thickets is not prevented and grazing by domestic stock is not intense. Stoddard (1931) and Leopold (1931) discuss many practicable features in adapting farm country to bob-white.

Attempts have been made from time to time to introduce into northern states a bob-white (*Colinus virginianus texanus*) from Texas and Mexico to augment the native stock. According to Leopold (1931), 6,000 such birds were liberated in Ohio in 1916, but it is doubtful if many of these survived. Introduction of these foreign birds is not to be recommended because the southern bob-white is of less vigorous stock, weighs less, and is less resistant to northern winters. By interbreeding with the native northern bob-white, it may readily undermine the vitality and natural hardiness of the entire population.

The practicality of raising bob-white artificially for liberation is a question. This has been successful in the case of a few

other species. At present, the cost of hatching bob-white in incubators or under hens and raising the chicks to maturity is too prohibitive for extensive liberation purposes. However, methods are now under investigation, and it is not unlikely that in the near future, the total expense of raising a pair of adult birds will be materially reduced. There is no reason to believe that artificially reared birds will be any more resistant to cold, heat, snow, lack of food, rain, and droughts than is the native stock. Therefore, there is the chance that a large proportion of any such release of artificially reared birds might be destroyed within a few months.

Even if the artificial rearing and liberation of bob-white may some day become practicable, this undoubtedly could not be done extensively enough to furnish birds directly for hunting. Such birds will best serve the purpose of adding to the breeding stock, as the maximum increase in population would have to be brought about by natural production. However, there is no value in liberating birds except into areas having suitable habitats to receive them. Without abundant food and shelter, they would not long survive.

The whole problem of increasing the population of bob-white reduces down to the establishment and expansion of habitat areas containing suitable cover and food. The preceding study of the fluctuations in the population of bob-white during the last 24 years indicates that, where given proper protection and habitat and when the climate is favorable, the species is capable of rather rapidly increasing its numbers by natural reproduction. With the increase in abundance, the birds must of necessity expand their areas and spread into new and favorable regions. It seems, therefore, that if new habitats for the bird are formed, natural reproduction will soon enable the species to fill in these areas without the necessity of liberating either imported birds or those that have been reared artificially. If, however, local areas of considerable size are found in the State in which no breeding stock is present, the liberation there of artificially reared native stock to serve as a nucleus for breeding purposes may be desirable; or birds in *nearby* localities may be trapped and imported.

RECOMMENDATIONS AS TO CONSERVATION.

In southern Georgia, Stoddard (1931, page 341) states that on some places it is safe to shoot approximately 25% of the

population of bob-white annually, where control of natural enemies is fairly adequate. On very large tracts of preserved land, as where several estates are located in a group and the owners are co-operating in the control of the enemies of the bob-white, it may be possible ultimately to harvest up to 50% of the crop and still leave a sufficient breeding nucleus. On other areas, no surplus is produced for hunting. Leopold (1931, page 87) states that an annual kill of 50% of the population is, at present, unsafe in the northern states, and indicates that 33% is about the maximum from which the species can recover during favorable years.

It is absolutely essential if the population of bob-white is not to be depleted that no more birds die each year than are raised, whether their death be due to natural causes or to hunting. Our population data for bob-white in Ohio, indicate, as was discussed above, that during favorable years, an average increase of 39% of the previous year's population occurs. This represents the maximum number available for hunting purposes during the 12 years in which a surplus of birds was produced. During the other 12 years in this period, the number of birds remained the same or there was a decrease in abundance. During these years, no birds at all would have been available for hunting.

If, 2,400,000 birds be taken as the average bob-white population for the State and 39% of these are available to the hunter during favorable years, this amounts to approximately 936,000 that may be killed. According to information kindly obtained for us by the Ohio Division of Conservation, there have been over 400,000 hunting licenses given out during each of the last four years. All of these licenses stand for potential hunters of bob-white. The total number of birds available for these 400,000 hunters would average about 2⅓ birds apiece for the season. This number is so small as to make the hunting of this species an impractical one for sport, even if such a small bag limit could be enforced.

The gravest danger lies, however, in possible extermination of the species in the State during those years when no increase or surplus is produced due to unfavorable breeding conditions, or when the number of breeding pairs have been reduced due to severe winter conditions. The killing by hunters of 936,000 birds during a single year would have wiped the species entirely out of existence in Ohio in 1909, 1912, and 1913 and nearly so

in 1914. A similar kill in 1917 or 1918 would have so reduced the number of birds left for breeding that recovery would have been insufficient to permit the species to survive the hunting season of the following year. Similarly, if hunters had killed 936,000 birds per year during the period beginning in 1926 when the bob-white population was decreasing from natural causes at the rate of 14% per year, the species would have been exterminated in the State by 1928. It is against this danger that the people in Ohio must guard, since it has been demonstrated above that the species is of interest not only to the hunter but also to the farmer and to the bird lover, and their interests must be considered.

The conclusion must be, therefore, that the population of bob-white in Ohio is *not* of sufficient size to permit a *general* open hunting season throughout the State. If hunting is to be permitted at all, it must be confined to local areas where the bird is sufficiently abundant to withstand the drain upon its numbers, where the amount of hunting may be carefully controlled, and where protection and food may be furnished during periods of stress.

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THE STATE PARKS OF HOCKING COUNTY, OHIO.

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Not far from Athens and to the southwest of Logan, the county seat of Hocking County, is an area of country unequalled in Ohio for its scenic beauty. This region has a wealth of natural beauty, for the most part still in its original condition. The attractiveness of this rugged area is enhanced by the virgin stands of hemlocks, poplars and oaks and the profusion of ferns, shrubs and flowers. Through the steep-sided, shady gorges wind trails through virgin forest made up of giant trees, the like of which are seen in few places in Ohio. This region is especially interesting to geologists and botanists as well as to those who love nature and the out-of-doors.

The recreational possibilities of the state parks are being appreciated to a greater degree each year, as indicated by the increasing attendance. The total number of visitors, coming from 38 states and Canada, in five recreational areas in Ohio, during the first ten months of 1931, was 256,557. Of this number 186,557 visited the parks in Hocking County, apportioned as follows: 51,648 at Ash Cave Forest Park, 53,049 at Rock House Forest Park, 75,765 at Old Man's Cave Forest Park and 6,095 at Cedar Falls Forest Park. The attendance figures compare favorably with those of the larger better known national parks of the country.

The state park domain includes Ash Cave Park of 262 acres, Old Man's Cave Park of 1,010 acres, Cedar Fall's Park of 30 acres, Conkle's Hollow Park of 723 acres, Rock House Park of 517 acres and Little Rocky Park of 290 acres, a total of 2,832 acres in the Hocking County series of State Forest Parks.

Under the able leadership of State Forester Edmund Secrest, who has so faithfully served Ohio for the past 26 years, a program was inaugurated and maintained, whereby tracts of forest land were set aside in accordance with a definite policy of conservation. Through Mr. Secrest's efforts, the State Forest Law was passed (1915) and more recently an amendment to it, which enables the state to acquire by purchase or gift

such areas which it is necessary to receive for the public good and may include sites of scenic value, virgin woodlands, and areas desirable for recreation and reforestation. Through the operation of this law, Ohio has acquired a total acreage of more than 50,000 acres; 45,429 acres of State Forest and 4,769 acres of State Forest Parks. Perpetuation of our timber supplies, protection from soil erosion, preservation of natural beauty are the fundamental principles of the forestry program in Ohio.

The aim of the park authorities is to maintain the natural features of the region in all their pristine beauty. Here we have an area which is for the most part a wilderness. One can find roads cut through country that has remained almost unchanged during the last fifty years. Another excellent feature about these parks is their accessibility. They are easily reached by improved roads. Fire hazards have been removed, water supplies provided, camp sites and parking places cleared, paths cut through the forests, and steps cut in the solid rock at points where travel is difficult, all of which add to the wilderness spot that touch of civilization so desirable to tourists, but which park authorities are anxious to avoid as much as possible. Artificial conditions which are necessary, are restricted to limited areas on the outside, so that the natural beauty for which the place was secured, might remain unchanged as far as possible.

The saddest of sights are the abundant evidences of vandalism in the parks throughout the country. I refer to the writing of initials and names and other inscriptions on the rocks, the destruction of signs, the plucking of wild flowers and tearing up of shrubs and young trees and the indiscriminate disposal of refuse. Either we are not a law-abiding country or our education has failed to give us a sense of responsibility for the protection of the beauties of nature. Students in our schools should be taught not only love for nature but its protection as well. Community organizations can render a good service in promoting a sentiment for the suppression of the various forms of vandalism in Ohio woods.

PHYSIOGRAPHY AND GEOLOGY OF THE AREA.

The region is a portion of a maturely dissected upland, commonly known as the Appalachian Plateau. The highlands consist of long, narrow ridges which are deeply indented by hollows and gullies, where small streams have worked their

way up the slopes, forming many minor projections on the ridges which present a very rugged or serrated appearance. The highland plains have been so completely dissected by major streams and their tributaries, that the remnants appear as a network of long ridges with narrow summits and steep slopes. Farming is largely confined to the summits of the ridges and along the valley plains. The hillsides are forested or are used for pasturage. The higher ridge-crests stand at an elevation ranging from about 1,040 to 1,160 feet above sea level. The majority of the hills are below 1,100 feet and the valleys have an altitude ranging from about 680 to 780 feet above tide, the relief being approximately 200 to 375 feet. Generally speaking the bottoms of the deep, narrow gorges are perhaps 200 feet from the top of the cliffs which form their walls. The area is drained by Pine Creek and Queer Creek and their tributaries. These streams unite to form Salt Creek, which flows southward into the Scioto River. They occupy broad, mature valleys and some of the tributaries have narrow flood-plains in their lower courses.

A few miles to the southwest of Logan, breaking off sharply from the rounded hills and broad, fertile valleys on the uplands which surround the city, the country becomes rugged, with well-defined, deep, rocky gorges and narrow valleys. There are two districts in which the gorges appear, a south one along the three branches of Queer Creek and a north one on Pine Creek. In the Queer Creek district there are eight or nine miles of gorges, including Ash Cave on the lower or East Fork, Cedar Falls on the central branch and Old Man's Cave on the upper end of the north gorge, known as "The Gulf." The Pine Creek district contains four gorges and narrow valleys and six or seven smaller ones about a mile long, all running south into Pine Creek Valley. All the streams which flow into Pine Creek from the north occupy deep, narrow chasms varying from 50 to 175 feet in depth. They are heavily wooded with hemlocks and hardwoods. These gorge-like valleys are less frequented than the others and to those who enjoy tramping, away from the well-trodden paths, this region is especially delightful. Naming them from the east these parallel valleys are as follows: Big Rocky, Little Rocky, Springer Hollow, Crane Hollow, Conkle's Hollow, and Spruce Run, all of which, with the exception of Big Rocky and Crane Hollow, are state parks. North of the Pine Creek valley is Rock House Park. It is

located at the upper end of a small tributary to Laurel Run, which flows into Salt Creek.

If one stands on the high points on the ridge-crests or on the fire-lookout near the Rock House, he is impressed with the remarkably even sky-line. In Hocking County and adjacent areas, the main ridges along the water divides rise to a rather uniform height, the average of which is not far from 1,060 feet above tide. The variation is commonly between 1,020 and 1,100 feet. This level marks a peneplaned surface which has been uplifted and dissected by subsequent erosion to a fragmental condition. It rises gradually eastward and can be traced into, and is correlated with the Harrisburg peneplane of western Pennsylvania. As the result of the development of this surface, an earlier peneplane, commonly known as the Cretaceous but now believed to be younger, was almost completely removed. This surface, well-developed on the ridge-crests of eastern Pennsylvania, has been referred to as the Schooley (Kittatinny) peneplane. The Harrisburg surface was uplifted and dissected, the streams cutting deep valleys with wide gradation plains along their courses, reducing the divides between the drainage basins to lower levels. This peneplane, if it may be so called, is known as the Worthington in Pennsylvania, where it appears as a broad strath along the major streams. It is far less complete than the Harrisburg surface and extensive remnants of the latter appear over wide areas. In Hocking County, in the park area, the Worthington surface stands at an elevation averaging about 920 to 940 feet on the spurs along the larger streams, but in general is nearer 1,000 feet for the entire area; the average altitude of this surface for Ohio is not far from 1,000 to 1,100 feet. It slopes gently upward into the Harrisburg level and is somewhat higher near the main divides and lower toward the central portions of the drainage basins. During Worthington time the streams dissected the Harrisburg surface and cut broad valleys well toward their headwaters. The Harrisburg and Worthington peneplanes occupy about one-third of the total area.

In late Tertiary time, just before the ice age, a still lower erosion surface, the Parker Strath, was developed by erosive agencies. The term "Parker Strath" is applied collectively by Wilber Stout, of the Ohio Geological Survey, to the remnants of old valleys which stand well below the Worthington level.

This new cycle of erosion was inaugurated by a slow uplift of the land as a result of which the streams were rejuvenated and began carving valleys in the elevated surface. The streams maturely dissected the older surfaces and cut rather broad valleys with moderate slopes, 200 to 290 feet below the mean level of the Worthington peneplane. The further development of the Parker cycle was arrested by the advance of the glaciers of Pleistocene time, which caused a general modification of the drainage systems of the region. Since the ice age, the streams have been engaged in eroding to still lower levels. Remnants of the Parker Strath appear along Pine Creek and Queer Creek at an elevation of about 700 feet. The valley slopes rise rather abruptly from the Parker level to the Worthington surface, then much more gradually to the Harrisburg peneplane, remnants of which occur on the higher ridges.

There is abundant evidence that the youthful streams which occupy the gorges are at present actively cutting headward, dissecting the upland valleys, which are broad and shallow. The latter border the gorges and break off abruptly at the heads of the valleys which terminate in a precipice that usually overhangs. On the upland is displayed the ancient topography of the Harrisburg and Worthington cycles, and below, the more rugged topography produced by subsequent erosion. It is true that the weaker rocks above the Black Hand conglomerate have allowed greater erosion and hence broader valleys would result, and the sharp change from the upland to the gorges below could be in part the result of a difference in the resistance of the rocks to the erosive agencies. The same principle is the explanation of the rock terraces in valleys such as the Grand Canyon of the Colorado River.

The formations exposed in Hocking County were laid down during the Mississippian and Pennsylvanian periods. The principal formations belong to the Waverly group, the lower division of the Mississippian. The sandstones, conglomerates and shales of the Waverly have a total thickness of nearly 1,000 feet and can be grouped in several distinct members. The subdivisions of the Waverly in Hocking County, according to J. E. Hyde* are as follows, the Bedford shale, Berea grit, Sunbury shale, Cuyahoga and Logan formations. The only formations which concern us here are the Cuyahoga and Logan. Each of these have their subdivisions. The Cuyahoga, about

*Stout, Wilber, Geological Survey of Ohio, Bull. 31, p. 43, 1927.

600 feet thick, is composed of three members, the Lithopolis, Fairfield and Black Hand. The Lithopolis is made up of shales with fine-grained sandstones, the Fairfield of coarse sandstones and conglomerate, and the Black Hand of massive, cross-bedded sandstone and conglomerate. The Logan formation is subdivided into four members, the Berne, an evenly bedded conglomerate; the Byer, a fine-grained sandstone; the Allensville, a coarse sandstone, and the Vinton, a fine-grained sandstone and shale. On the ridges, above the Waverly group, lie the lower divisions of the Pennsylvanian Coal Measures, consisting of shales, clays, sandstones, conglomerates, coal and thin beds of fossiliferous limestone. The formation which concerns us most in a description of the features of the parks, is the Black Hand member of the Cuyahoga formation. This member is thick in Hocking County, being from 100 to 200 feet. It is for the most part a massive, conglomeratic sandstone, forming numerous prominent ledges in the streams which cut deeply into it. Where the streams have cut into it to any great depth, steep-sided gorges are produced. The walls or cliffs of these narrow valleys are usually in a vertical or overhanging position. The scenery of the park area is almost wholly the result of the weathering and erosion of the hard, resistant Black Hand member. A more detailed description of this member would include the fact that in Hocking County it is non-fossiliferous and is made up of sandstone and conglomerate. It is commonly sandstone with small pebbles of white quartz varying in size from a pea to one-fourth or one-half of an inch in diameter, scattered through the body of the sandstone in thin streaks. It is beautifully cross-bedded in places. The color varies, being dark brown or red on the outside where it is weathered. Where covered with lichens or moss it presents a green appearance. Beneath the weathered portion the sandstone is yellow or buff and in some places red or orange-red. Differential weathering has added to the picturesqueness of the cliffs. The beds of sandstone and conglomerate of the Black Hand member vary greatly in their resistance to weathering and erosive agencies. The weaker beds frequently form hollows or caves, whereas the more resistant layers stand out as projecting ledges or form benches. The Black Hand member is broken into huge blocks by joints; the wide spacing of the joints and the thickness of the beds is responsible for its massive character.

At present the dip of the beds is about 30 to 35 feet per mile to the southeast. At the time the Cuyahoga formation was laid down, Ohio was a shallow sea. A study of the Black Hand conglomerate and sandstone appears to indicate that strong currents were sweeping gravel from the southeast. The coarseness of the material, the abundance of cross-bedding and its direction of slope to the north, indicate delta growth or bar development under strong oceanic currents. When traced into Pike County to the westward and southward into Scioto County, the Cuyahoga conglomerates change rapidly to shale. Where the Black Hand member is thick and composed of sandstone and conglomerate the picturesque gorges are present, but where it is shale these features are absent.

FLORA.

A description of the park area would not be complete without a brief discussion of the flora of the region. According to State Forester Edmund Secrest, the Hocking County Park area has the finest stand of virgin forest in Ohio. It is least disturbed of any forest in the state; in some of the gorges few if any trees have been removed. In Cedar Falls valley stands what is said to be the tallest tree in Ohio, a hemlock 149 feet high and 40 inches in diameter. The value of the timber, in the Rock House Forest Park, at the time of purchase was worth more than the purchase price of the area. The forests of the region are interesting because they represent different types, the one in the gorges and narrow valleys the cool, northern forest as is found in New England and northern states and another on the uplands which is a southern type. The northern forest is represented by the hemlock, beech, sugar maple, and yellow birch and the southern by the chestnut, tulip-tree, pitch pine, jersey pine and sorrel-tree.

The Hocking County area has long been known by Botanists as one of the richest collecting grounds in Ohio. According to the report by Griggs,* in its general relationships the flora may be described as an outlier of the great Allegheny Mountain flora, from which it derives a considerable number of plants, like the Great Rhododendron, which do not occur elsewhere in Ohio. There are also a number of plants, like the Lycopodiums, which belong in the Canadian area and come down into Ohio

*Griggs, Robert F., A Botanical Survey of the Sugar Grove Region. Ohio Biological Survey, Vol. I, Bull. I–IV, 1913–1915, pp. 248–340.

from the north, reaching their southern limits in this region. There is a third element of southern plants, such as Aralia Spinosa, which stretch up from Kentucky and Tennessee and reach their northernmost limits in this area. The region is therefore interesting because of the possibilities of collecting, the study of the geographic range of plants and the ecology.

The deepest forest in the region is that formed by the hemlock, which is most luxuriant on the sides and bottoms of the deeper ravines. In the deeper gorges, conditions more nearly resemble those of the tropical rain-forest than anywhere else in the area. The humidity is high and the shade is so intense in some places as to prohibit the growth of plants other than the forest trees themselves. The Liriodendron forest occurs under conditions little different from the hemlock forest it is replacing. Its most typical development is present in the short, steep ravines, surrounded by high hills, within which the timber is unusually tall, straight and free from knots and wind checks. The tulip-tree is most characteristic of this type of forest. Chestnut, hemlock, butternut, American beech, red maple, tupelo, shagbark hickory, white oak, quercitron oak, sweet birch and red mulberry occur in order of abundance. In general a variety of smaller trees and shrubs grow beneath the forest canopy. Among these are the witch-hazel, flowering dogwood, wild hydrangea and others. The herbage is composed of a large number of species. In the most shaded woods, herbs with evergreen or hibernating leaves are abundant and conspicuous. Where not too shaded there is a rich development of vernal herbs with showy flowers. Later in the summer the places of these are taken by another group. The phanogams without chlorophyll are represented by the parasitic squaw-root and beech-drops and saprophytic Indian-pipe and smooth pine-sap.

The upland forest is divided into the pine and oak forests. The former occupies the poorest soil capable of supporting arborescent plants and bears a general resemblance to the pine barrens below the glacial moraines. The most important trees are the pitch-pine, scrub-pine, quercitron oak, chestnut and sorrel-tree. The pine forest occurs on the more exposed ridges where conditions are severe. Where the conditions are less severe the pines give way to the hardwoods and a mixed oak forest. The rock chestnut oak is sometimes the dominant tree. With it are present the white oak, quercitron oak, sorrel-tree,

chestnut, shagbark hickory, tupelo, and red maple. The upland oak forest coincides with the limits of arable soil and originally covered a large part of the region. As a result of lumbering most of the oak today is the worthless black oak.

PROCESSES INVOLVED IN THE FORMATION OF THE GORGES AND THEIR FEATURES.

The canyon-like valleys are youthful and exhibit all the characteristics of youth, such as waterfalls, clear, swiftly-flowing streams actively cutting downward, steep walls with bold rock outcrops and a V-shape or box-canyon cross-section. The rate of down-cutting has been rapid and weathering and erosion have not been sufficient to reduce the resistant Black Hand conglomerate to slopes, resulting in narrow, steep-sided valleys. Most of the streams in the region terminate in "coves" or steep-walled, amphitheatre-like slopes. The head of the valley usually ends abruptly in a semi-circular, overhanging cliff, or a series of ledges forming waterfalls or rapids. Above the cliff, the streams flow in broader, shallower valleys, which represent an older erosion surface. There is much evidence that the streams are at present actively extending their gorges headward. Usually the "coves" are present at the heads of the gorges, but in at least one case, at lower Old Man's Cave, there is one which does not occur in that location. The streams in cutting downward have in many instances produced a series of rock benches, forming one might say, giant steps up the valleys.

In the "coves" at the heads of the gorges, as at Cedar Falls, Ash Cave and Conkle's Hollow, not to mention others, there are usually fine examples of pothole action. The undermining of the base of the cliff by pothole action is doubtless the cause, in large part, of the gradual retreat of the falls and the lengthening of the gorges. The sandstone caves, so common in the region are the result of weathering and pothole action in the "coves," and undercutting by the streams where they impinge against the walls of the narrow gorge. The streams are, with few exceptions, temporary ones. During a dry summer, water flows through the valleys only during periods of heavy rainfall. At such times the streams have great volume and consequently great erosive power.

There is evidence to indicate that the jointing of the conglomerate is to some degree responsible for the canyon-like

valleys. The Black Hand member is broken into huge blocks by at least two joint systems, running at about right angles to each other. The tendency is for the smaller streams to follow the larger joints which offer less resistance to erosion. At Ash Cave, Cedar Falls, Conkle's Hollow and other places, especially where there are small tributaries, one can observe the tendency to follow the lines of least resistance along the joints. The block-jointing tends to produce angularities of the gorge walls and is also responsible, to some degree, for their vertical position.

Differential weathering is also the cause of some of the picturesque features of the gorges. Water, carbon dioxide, and oxygen find their way into the joints and bedding planes in the conglomerate and enlarge them, making it easier for running water to erode. Where the rock is resistant to solution or chemical decay, the beds project and where rapid weathering takes place, caves with overhanging ledges are produced. Rock decay along the joints has allowed trees and shrubs to take hold and by extending and enlarging their roots, the rock is further disrupted. In the environment of the shady glens the moisture content of the air is near the saturation point and weathering is more rapid than on the uplands. The mosses, lichens and shrubs which grow in abundance on the walls and talus slopes at the base of the cliffs, hold the moisture and aid in the process of rock decay. When first quarried the Black Hand sandstone is friable but on exposure to weathering becomes hard and durable. Usually the upper thickness of perhaps 5 or 10 feet of the Black Hand member projects prominently, forming overhanging ledges such as the roofs of Old Man's Cave and Ash Cave. It happens that the exposed top of the cliff becomes much harder by exposure to weathering, whereas the protected portion weathers away more rapidly, forming an overhang. Processes similar to those which are operating to form the gorges in Hocking County are also responsible for other scenic chasms, such as The Dells of the Wisconsin, Watkins Glen, Niagara George, Ausable Chasm and others.

OLD MAN'S CAVE PARK.

This is the most popular of the Hocking County group of parks and was selected by the Ohio Federation of Women's Clubs as the outstanding beauty spot in Ohio. The principal features are two caves, upper and lower Old Man's Caves,

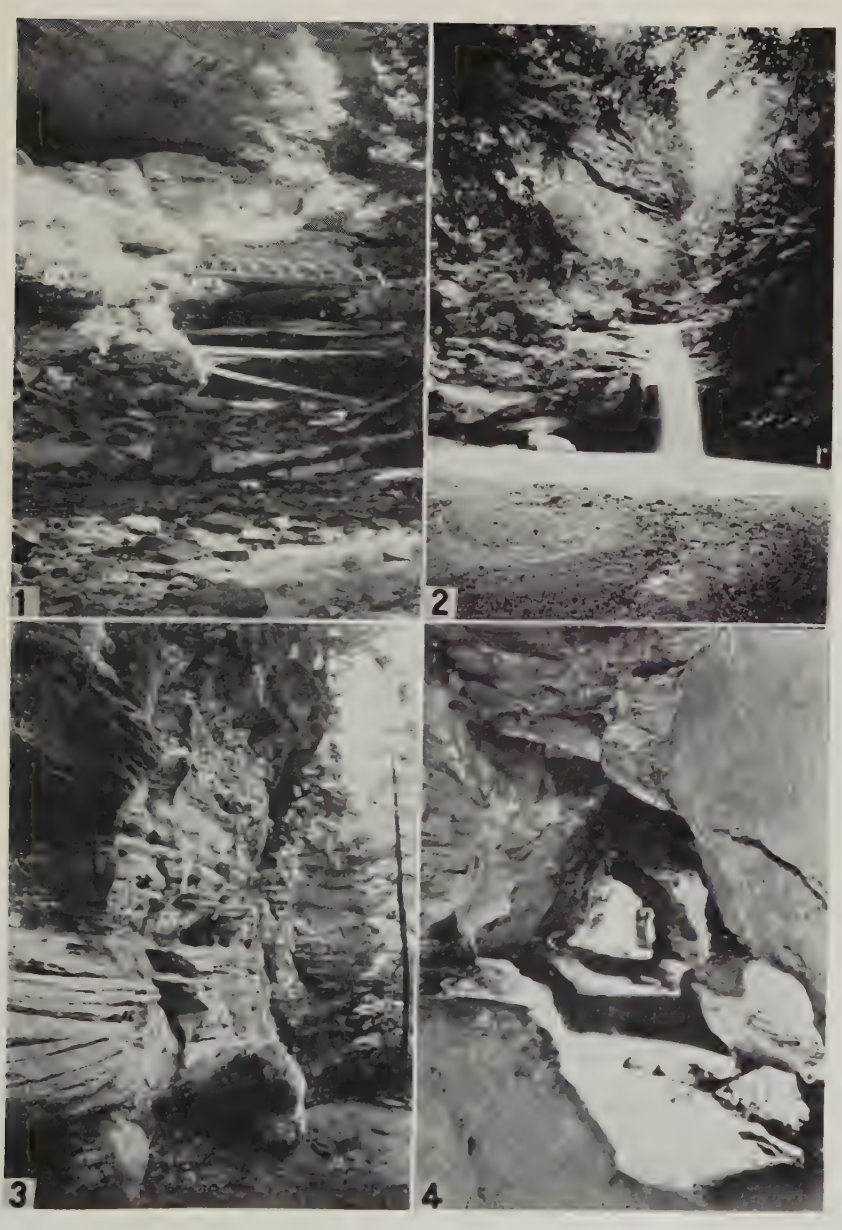

FIG. 1. Upper Old Man's Cave.
FIG. 2. Lower Old Man's Cave and Falls.
FIG. 3. Rock House Cliff.
FIG. 4. Interior of the Rock House.

picturesque waterfalls and two miles of heavily wooded gorge. The upper cave is located in a vertical cliff about 75 feet above the creek. Here a combination of weathering and erosion has produced an overhanging cliff. It is probable that the stream, when at the level of the cave, impinged upon the cliff and undermined it. Further deepening of the valley by the stream has lowered it below the level of the cave. The overhanging cliff at upper Old Man's Cave projects about 100 feet above the creek. The cave is not far from 200 feet long and 50 feet deep and has the form of a half-dome, a shape characteristic of all the caverns in the region. This is the form one would expect where streams have undermined a cliff and produced an overhang.

The gorge above and below the upper cave offers as fine an example of a glen as can be found anywhere. Giant hemlocks and hardwoods raise their leafy boughs above the gorge to the sunlight. The towering walls of the miniature canyon rise a hundred or more feet above the creek. Beneath the forest canopy are a profusion of ferns, shrubs and flowers, all of which add materially to the beauty of the valley. The width of the gorge above upper Old Man's Cave varies, widening and narrowing, from 30 to 50 feet. The upper gorge ends in a picturesque "cove," a semi-circular, overhanging cliff. The stream on the upland flows in a broad, shallow valley and falls over the sandstone ledge into the gorge below. A large, circular pool of water marks the pothole at the base of the falls. A cave, produced by the swirling water in the pothole at times of heavy rain, is present. The upper gorge ascends in places by rock benches, the stream descending by a series of falls or rapids.

Below upper Old Man's Cave, at a distance of perhaps a hundred yards, are the lower falls and lower Old Man's Cave. Here the water falls a distance of 30 to 40 feet to a pothole below. The cave is not far from 200 feet long, 50 feet wide and 40 to 50 feet high. There is evidence that in time of heavy rain, the water at the base of the falls accomplishes the undermining which produced the cave. The pool in the pothole is approximately 50 feet in diameter. The combination of waterfall, towering precipitous cliffs, mirror-like pool and cavern with the added beauty of the forest, make it easily the most scenic spot in the region. Below the lower falls the gorge is considerably wider and deeper than above. The stream has a small floodplain near its mouth and the benches over which

the creek flows are not so conspicuous. Great heaps of talus, composed of enormous blocks of sandstone and conglomerate, have accumulated at the base of the towering cliffs. On the whole the lower gorge is perhaps less scenic than the upper one. A very pleasant walk is possible by following the trail down the lower gorge and up Cedar Falls valley to Cedar Falls and across the upland back to Old Man's Cave.

CEDAR FALLS PARK.

Cedar Falls is located at the head of a gorge the stream of which flows into Queer Creek. There is the characteristic semi-circular cliff over which the water falls a distance of 50 or more feet, a pool at the base of the falls and a cave produced by pothole action. The gorge below Cedar Falls is similar to the one at Old Man's Cave, in fact it is really an extension of Old Man's Cave Park. It is possible to walk by trail from Old Man's Cave through an attractive, heavily wooded valley to Cedar Falls.

ASH CAVE.

Ash Cave is perhaps not the most beautiful spot in the region, but it is by all means the most spectacular. The ravine or gorge is short and ends in a gigantic cavern. A stream flowing in a broad, shallow valley on the upland, dashes over a semi-circular, projecting cliff or overhanging ledge of sandstone which forms the roof of the cave, to the bottom of the gorge a hundred feet below. The cave is approximately 700 feet long, 100 feet wide and 90 feet high. The origin of the cavern is not unlike the others in the area. The projecting ledge of sandstone which forms the roof of the cave is more resistant to weathering than the more protected beds of sandstone and conglomerate beneath. At times, during periods of heavy rainfall, pothole action is an important factor in undermining the cliff. The water sweeps away the accumulated debris at such times when the floor of the gorge is covered with water. When there is sufficient water in the stream, the falls are beautiful and in winter the ice formations are well worth seeing. The gorge is heavily wooded and very attractive.

ROCK HOUSE.

Many would call this celebrated natural feature the most interesting and unique in Ohio, a natural jewel in a splendid setting. It is not only unique but spectacular as well and

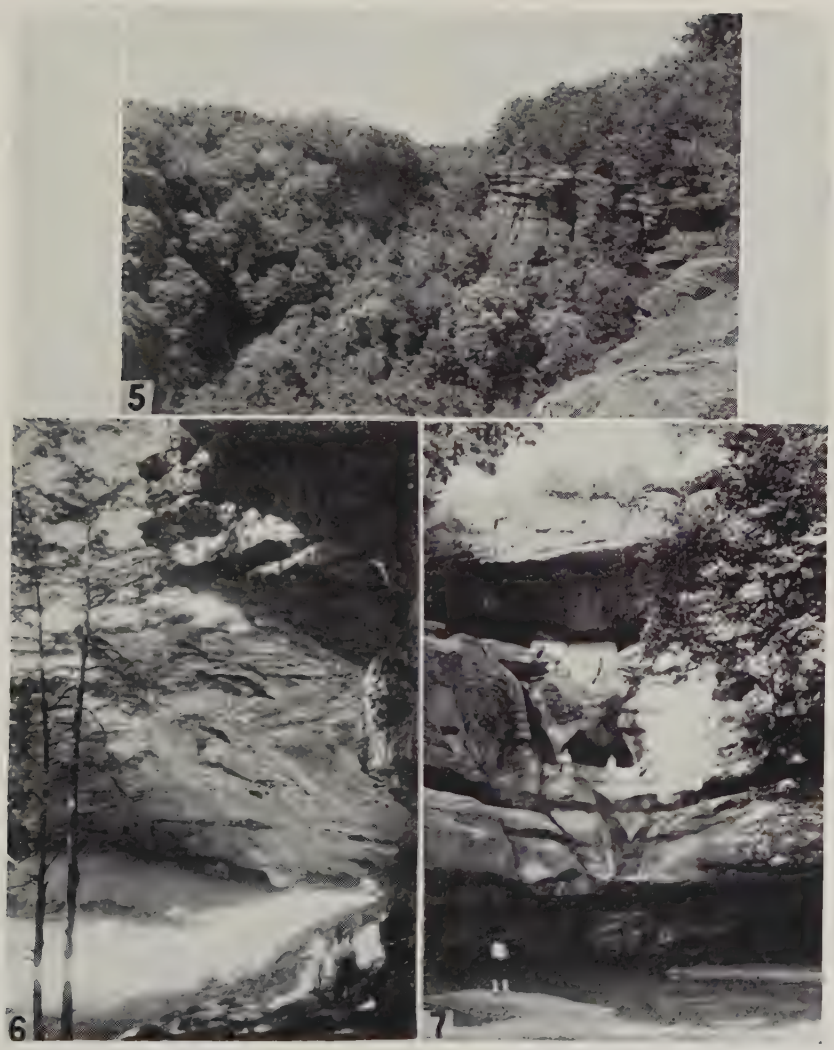

FIGURE 5. Conkle's Hollow.

FIG. 6. Ash Cave.

FIG. 7. Cedar Falls.

travelers say there is nothing just like it in this country. It is one of the best known of all natural attractions in Ohio and has been a popular beauty spot in Hocking County for more than a half-century. It is a house hewn out by nature from a wall of solid sandstone and conglomerate, 150 feet high. The Black Hand sandstone is here displayed at its best, a towering, overhanging cliff rising vertically from the gorge below. It shows the bright color where freshly exposed, red and brown where weathered and green where covered with moss and lichens.

The cave is about 200 to 225 feet long and varies from 25 to 30 feet in width at the level of the floor and is approximately 25 to 30 feet high. In most caverns the entrance is a narrow aperture, but here the sandstone has been weathered along the joints, forming a long corridor, opening out at the ends in two gothic doorways, at a point about half the height of the precipice. Along its front, enlargement of the joints by weathering has produced large sandstone pillars, the portals between them serving as windows. Nature has carved a gothic hall with windows and columns to bear the weight of the massive roof. There are five pillars and seven openings, the former being widest at the top, varying from 15 to 40 feet in diameter and from 15 to 20 feet in height. They are very irregular in shape, the result of differential weathering. The irregular outline of the windows stands out sharply against the more luminous background of the forest, as viewed from the darkness of the cavern. Each window is located along a large joint where weathering has been most effective. The joints are everywhere visible and can be easily traced from the windows along the roof and into the wall which forms the rear of the cave. The same process of weathering which formed the windows is at present taking place on the rear wall of the cave. Enlargement of the joints has produced vertical clefts in the wall, the blocks between standing out in bold relief. One set of vertical joints extends at right angles to the face of the cliff and breaks the sandstone into blocks 15 to 40 feet in width. Another set extends at right angles to the above mentioned set and runs parallel to the face of the cliff. Enlargement by weathering along one of these joints is responsible for the elongate corridor. This joint is very conspicuous along the roof and can be seen along the floor in some places. A cross-section of the cave at right angles to the cliff, gives an outline

like that of the gothic arch, wider at the floor, the walls converging upward and disappearing along the joint which runs the entire length of the cave. The end windows are located along this master joint. The cave is the product of differential weathering along two sets of master joints running at nearly right angles to each other. Where the cave is widest the sandstone crumbles readily and is more easily weathered than elsewhere. This is borne out by the hollows formed on the weaker sandstone on the back wall of the cave. In the grotto the well-bedded sandstone forms benches, one of which is about eight feet high and runs the entire length of the cave.

Rock House Park has other attractive features. It is possible to walk along trails which lead through the wooded country. A view from the fire-tower located not far from the Rock House gives one an excellent view of the surrounding region.

CONKLE'S HOLLOW.

Conkle's Hollow is not as well known and not as easily reached by good roads, but in some respects surpasses the other parks. It is different and has an individuality all its own. It is a deep rocky gorge, unimproved and nearer its original condition than some of the other areas. It is a wilderness, with great hemlocks and hardwoods and a profusion of ferns and shrubs in the moist, shady environment beneath. The canyon, if it may be so called, is wild and picturesque, with towering cliffs which rise more than a hundred feet above the floor. In some places the cliffs overhang and so narrow is the gorge that the writer estimated the distance at the top, from cliff to cliff, to be not more than 300 feet. Conkle's Hollow is most spectacular in winter when the cliffs are everywhere visible. The gorge is of unusual interest if one is prepared for strenuous climbing, to cover three distinct levels in the rocky hollow. The gorge ends abruptly in a "cove" similar to the others in the region already described. The valley narrows to a defile with almost unscalable cliffs at its head and ends abruptly in an overhanging ledge of sandstone. The cave is semi-circular in shape and not far from 50 feet long, 30 feet wide and 25 feet high. The water dashes into the cave from the upland through a cleft in the roof. A pothole, marked by a pool of clear water, occupies a large portion of the floor.

WEATHER CONDITIONS DURING WASHINGTON'S WESTERN JOURNEY OF 1770.

GUY-HAROLD SMITH.*

In the autumn of 1770 George Washington, at that time a distinguished planter living at Mt. Vernon, Virginia, made his most westward journey into the Ohio country.† On this "tour to the Ohio" he ventured westward into the interior of the continent when very little was known about systematic meteorology. He left Mt. Vernon on October 5 and returned on December 1, being absent from home exactly eight weeks and two days. While there was a chance that very disagreeable weather might be experienced, there was also the possibility that pleasant autumnal days, now known as Indian summer weather, might make the journey an enjoyable excursion.

Washington was not unfamiliar with the weather of autumn in the region of the Upper Ohio Valley, for in 1753, when he was sent by Governor Dinwiddie to deliver a communication to the French Commandant at Fort Le Boeuf, he experienced very severe weather before he returned. He set out on this journey the last day of October and was in the northwestern part of Pennsylvania during the latter part of December, and here he experienced very cold stormy weather. It was not until January 16, 1754, that he returned to Williamsburg, ending a long and tedious journey requiring two and a half months. Certainly it was, from the standpoint of weather, a poor time of the year for travel, but military expediency required that it be not delayed.

The journey of 1770 was begun a little earlier than the trip to the French post, when the country must have been most beautiful, for the forests would at that time change from verdant to the various colors of autumn. As the season advanced the falling of the leaves would facilitate the examination of the terrain, avowedly one of Washington's chief motives in making the journey.

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*Member of the Ohio George Washington Bicentennial Commission.

†Guy-Harold Smith: "Washington's Camp Sites on the Ohio River," Ohio Archeological and Historical Quarterly, Vol. 41, 1932, pp. 1–19.

Washington, in keeping his diaries, included numerous notes on the passing weather, and it is from the record of October, 1770, that we can glean some information regarding weather conditions of that season. For this particular month he kept a separate record as a supplement to his longer journal.

The record of the weather is taken from Hulbert's transcription* of Washington's diary which he kept on his western tour. As a matter of fact he kept an extended journal which he entitled "Remarks and Occurs." in addition to the terse diary labeled "Where and how my time is Spent." His weather record is entitled "Acct of the Weather—in October" and is as brief as his diary. It appears that he did not keep a separate account for the remainder of his journey, but incorporated certain remarks about the weather in his journal.

Since his record for October, 1770, is fairly complete with an entry for every day, it is presented below in order to give continuity to the account. It is unfortunate that a more complete record is not available, but in these brief statements we have a valuable bit of information about the weather. His account is sufficiently detailed to permit an interpretation of the general distribution of the weather elements during the month of October.

"Acct of the Weather—in Octobr."

Octr 1st Wind Southwardly and Warm with flying Clouds.—
2. Raining, Hailing, or Snowing the whole day—with the Wind Northerly Cold & exceeding disagreeable—
3. Clear but Cold—Wind being very high from the Northwest—
4. Clear and pleasant—Wind being fresh.—and very fresh.—
5. Clear, Warm, & remarkably pleasant with very little or no Wind
6. Again clear and pleasant still
7. As pleasant as the two preceeding days
8. Pleasant forenoon—but the Wind Rising about Noon it clouded & threatned hard for rain—toward Night it rained a little & ceased but contd Cloudy
9. Exceeding Cloudy & heavy in the forenoon and constant Rain in the Afternoon
10. Cloudy with Rain & sunshine alternately.
11. Wet Morning with flying Cloud afterwards—toward the Evening the Wind sprung out at No West—
12. Rain in the Night with flying Cloud accompanied with a little Rain nw and then all day—cold & Raw—
13. Clear and pleasant Wind tolerably fresh from the Westward all day
14. Very pleasant but Wind fresh in the Afternoon.
15. Exceeding Cloudy & sometimes droppg. Rain but afterwds clear
16. Frosty Morning—but clear and pleasant afterwds clear
17. Exceeding warm & very pleasant till the Evening then lowering
18. Misty & Cloudy in the Evening the Forepart of the day being very warm
19. Misty & cloudy all day

*Archer Butler Hulbert, Washington's "Tour to the Ohio" and Articles of "The Mississippi Company," Ohio Archeological and Historical Society Publications, Vol. XVII, 1908, pp. 431–488. Transcription on pp. 448–449.

20. Misty—but the Evening clear tho somewhat Cool—
21. Cloudy & very raw & cold in the forenoon—about Mid-night it began to Snow & contd to do so—more or less all the remaing part of the Night & next day
22. Very raw & cold—Cloudy & sometimes Snowing. & sometimes Raining
23. Exceeding Cloudy and like for Snow—& sometimes really doing so—
24. Clear & pleasant Morning but Cloudy & Cold afterwards
25. Rain in the Night but clear & warm till abt Noon—then Windy & Cloudy
26. Clear and pleasant all day
27. A little Gloomy in the Morning but clear, still, & pleast afterwards
28. Much such a day as the preceeding one
29th Pleasant forenoon & clear but Cloudy and Wet afternoon.—
30. Raining in the Night—Raw cold & cloudy forenoon but clear & pleasant afternoon
31. Remarkably clear & pleasant with but little wind—

It appears from this account that Mt. Vernon, on the first day of October, 1770, was experiencing the typical warm weather at the front of an approaching cyclone. The next day brought rain and snow, indicating that the cyclone was a well developed storm. Such a storm certainly was more or less unusual as compared with present weather conditions, for it was early for snow in tidewater Virginia. The thermal gradient must have been unusually steep, for Washington describes the winds as warm on the 1st of October and they must have been particularly strong, for he observed that the clouds were flying, certainly indicative of winds of moderate velocity at least. On the second day the winds were northerly and cold. With snow falling the temperature must have fallen to near freezing, though it would not be necessary that the surface temperature be at 32° F. The ground so early in the autumn would still be warm, therefore the lower stratum of the atmosphere would be slightly above freezing. Such a blustering snow squall* is usually one of the first signs of approaching winter and unless it is followed by the cold weather which is sometimes the accompaniment of a stagnant anticyclone there is little danger of frost. Such storms are usually associated with well developed cyclones of autumn and may last from one to three or four days.

The average date of the first killing frosts† of autumn in the vicinity of Mt. Vernon is between October 21 and November 1. Only twice in the 20 years between 1895 and 1914 did the date of the first killing frost occur 15 days earlier than the average. From this record, made with modern

*Charles F. Brooks, "Why the Weather?" New York, 1924, p. 175.

†William Gardner Reed, "Frost and the Growing Season," Section I, Atlas of American Agriculture. Washington, 1920, p. 35.

instruments, it is clear that the Mt. Vernon section of tidewater Virginia experienced a cold snap somewhat earlier than is usual for that region.

The storm which brought snow to Mt. Vernon moved rapidly eastward bringing the area into the cold western portion of the cyclone. The center of the disturbance must have passed almost directly over Mt. Vernon or to the southward, for Washington notes that the wind was northerly. The following day, October 3, it changed to the northwest, indicating a continued eastward movement of the center. On the 4th of October the winds were still "fresh—and very fresh," but the sky was "clear and pleasant" just as we would expect under anti-cyclonic conditions which follow a cyclonic disturbance.

It was on the 5th of October that Washington, Dr. James Craik, a personal friend of his, and their servants set out for Fort Pitt, from which point they intended to embark on their extended journey down the Ohio to the mouth of the Kanawha River. The day was unusually pleasant, for Washington states that it was clear and warm with very little wind. His description of the weather for that day in relation to the conditions which preceded is indicative of high barometer. The sky was clear with very little wind and the next two days brought the same kind of weather. The area of high pressure must have been rather stagnant, tending toward maintaining clear weather for three or more days.

The fair weather ended for Washington on the eighth of October, but he had set a rapid pace and was by that evening well beyond the Shenandoah Valley. On that day the forenoon was fair, but in the afternoon the sky clouded up and in the evening it rained a little. Washington does not give any information about the wind and the temperature, so we cannot be sure that the change in weather was due to an approaching cyclonic disturbance or to a local convectional storm. Since he does not mention thunder and lightning, but does speak of the cloudy condition, particularly on the 9th, when it was "Exceeding Cloudy & heavy in the forenoon," it appears that the eastern part of another well developed storm was extending the eastern border and its accompanying cloud area over the country being traversed by Washington. In the afternoon of the ninth a continuous rain is an additional feature which lends plausibility to the interpretation made above. On the tenth the rain alternated with sunshine, but the morning of the

eleventh was wet. By the afternoon the storm center passed and toward evening the wind came out of the northwest. This is the first time Washington had recorded the direction of the wind since the third, thus we may conclude that the coolness probably moved him to make a note on its direction.

He recorded that the twelfth of October was "cold & Raw" with the wind out of the northwest. The storm had advanced eastward and Washington was again experiencing the cold northwest winds and the accompanying weather conditions characteristic of the westernmost portion of the cyclonic storm of autumn. He must have been reminded of the cold, bitter days which he endured on his journey to Fort Le Beouf in the autumn of 1753.

The wind had changed to westward by the 13th of the month, suggesting that the storm center was advancing toward the northeastward, or it may mean that the normal westerly or southwesterly winds were being established as the cyclonic disturbances became farther removed from southwestern Pennsylvania, the region then being traversed by Washington. It was on this date that he passed over ground familiar because of his engagement with the French at Fort Necessity in 1754. Curiously enough Washington did not commit to paper any reminiscences on his unhappy experiences here. In his journal he wrote briefly about the land and the weather. On the evening of the 13th he arrived at the home of William Crawford, his western agent, who accompanied him on his journey down the Ohio and later surveyed land for him upon the Ohio and Kanawha Rivers.

The fourteenth was also pleasant, the wind freshening in the afternoon, but Washington failed to note the direction. In view of the weather of the following day it is logical to assume that the wind came from a southerly or easterly quarter, presaging the eastward movement of a low pressure area which was then centered somewhat to the westward. The fifteenth was cloudy with occasional but light rain. It is probable that the storm center had moved eastward bringing the area south of Fort Pitt into the southern portion of the cloud cover. In the evening it was clear, permitting nocturnal radiation to lower the temperature to near freezing, for the morning of the 16th of October was "frosty." It was clear that day and later in the afternoon the weather was pleasant. The cyclonic disturbance had moved onward and the day was ideal for the

business Washington had to discuss with Crawford. By evening he was again on his way toward Fort Pitt.

By the 17th of October another storm was approaching, for the day was "Exceeding [ly] warm & very pleasant." Washington does not give the direction of the wind, but the fact that the day was very warm lends plausibility to the assumption that warm air was being imported from the southward as another area of low pressure moved eastward toward western Pennsylvania. He described the evening as "lowering," an expression sometimes used to describe a heavily overcast sky.

The next day it was very warm in the "Forepart," but by evening it was cloudy and misty. This inadequate report on the weather makes it difficult to guess the distribution of the weather elements, but the weather of the 18th seems to have been that which accompanies an autumnal disturbance which is not sufficiently developed to bring heavy precipitation. The storm probably advanced slowly, for the 19th was also "misty & cloudy," and even the 20th continued misty. In the evening, however, the sky cleared and the weather became cool. The sequence of weather events is rather convincing that again Washington, on the day he began his journey down the Ohio River, was experiencing the cool weather which usually follows the passing of a cyclone of autumn.

From his account it is not unreasonable to interpret the weather in terms of the conditions that are related to the more or less regular movement of the low pressure areas eastward across the United States at a season of the year when the tracks followed by these storms lie somewhat southward of the more frequented paths of the summer months. It appears that during Washington's long journey into the interior of the continent of North America several well developed cyclones passed far south of the Great Lakes and as they moved forward brought unseasonably cool autumn weather southward to the latitude of Ohio and Potomac Rivers.

As mentioned above the cold weather accompanying a cyclone greeted Washington as he began his descent of the Ohio River on the 20th of October. For the next five days ill weather was his fortune. It rained and snowed almost every day. He does not mention the direction of the wind, so we are unable to make more than a guess at the general weather conditions. On the 21st it was "very raw & cold" and on the 22nd he made the same notation in his weather

record. The weather had not improved much by the 24th except that it was "clear & pleasant" in the morning. It was cloudy and cold later in the day, but there is not enough information to permit a detailed discussion of the general weather conditions. The long period of cold, raw days seems to indicate that a cold mass of air was spreading southward mixing with a warmer stratum producing in the latter and at the zone of contact sufficient condensation for a heavy cloud cover, but not enough to produce heavy precipitation. The weather conditions were not sufficiently severe to impede the progress of Washington's party, for by the 22nd of October they were 75 miles below Fort Pitt, and also he makes no comments about the river or the tributaries which would indicate that conditions were unusual, except that he recorded on the 22nd that the water was "pretty swift" in places.

The 23rd of October was a rather unpleasant autumn day. He remarks that it was "Exceeding Cloudy & like for Snow— & sometimes really doing so —." The 24th was a little better "Clear & pleasant Morning but Cloudy & Cold afterwards." On the 25 there was "Rain in the Night but clear & warm till abt Noon—then Windy & Cloudy." It seems that during this three day period the approach of autumn was being heralded by cold cloudy weather as the moisture content of the atmosphere was being reduced.

On October 25th Washington noted the effects of a wind storm of earlier date. Some miles below Wheeling he came to a stream entering the Ohio from the west, which the Indians called "broken Timber Creek;* so named from the Timber that is destroyed on it by a Hurricane; . . . ." It is interesting to note Washington's use of the term, hurricane. On his voyage with his half-brother, Lawrence, to the Barbadoes in the autumn of 1751 the ship was caught in a severe storm and Washington wrote in his journal on October 19th that "It was universally surmis'd their had been a violent hurricane not far distant." He was not unfamiliar with winds of hurricane velocity.

The stormy weather which Washington experienced on the first six days on the Ohio River soon changed for the better. He was now down nearly as far as the site of Marietta, Ohio. On the night of October 26 he camped just above the mouth of the Little Muskingum where Reno is now located. It was

*Probably Sunfish Creek.

"Clear and pleasant all day." In his extended journal the final paragraph of his entry of October 26 reads "This day provd clear and pleasant, the only day since the 18th that it did not Rain or Snow, or threaten the one or other very hard."

On the 27th he continued down stream. It was "A little Gloomy in the Morning but clear, still, & pleast afterwards," and the 28 was "Much such a day as the preceeding one." The three successive days of pleasant weather indicate that anticyclonic conditions were in control. It is regrettable that Washington failed to record the wind direction so that his position in respect to the pressure areas could be determined.

On the 29th of October Washington rounded the Great Bend and ran into another storm area, or considering his rate of travel, a storm area ran into him. A day described as having a "Pleasant forenoon & clear but Cloudy and Wet afternoon—" was his lot. Of the 30th he wrote, "Raining in the Night— Raw cold & cloudy forenoon but clear & pleasant afternoon." The last day of October was "Remarkably clear & pleasant with but little wind." During the last three days of October he had passed through a storm area into the clear fair weather of an anticyclone. The order of the weather phenomena makes this assertion very plausible.

His systematic record of the weather was concluded with his entry of October 31 but from his journal we may glean a few statements which give some information about the weather during the month of November, 1770. The quotations in the remainder of this paper are taken from Fitzpatrick's transcription* of Washington's journal. His record is devoted to other matters hence his remarks on the weather are incidental and so limited that it is next to impossible to discuss in detail the general distribution of the weather elements.

During the first four days of November he made no comment on the passing weather, but on the 5th, the day he walked across a strip of bottom land below the Great Bend† and camped some miles up stream. He concludes his entry for that date with " . . . we Incamped, the afternoon being rainy, and the night wet." Again it appears that a storm of autumn had overtaken him.

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*John C. Fitzpatrick, "The Diaries of George Washington, 1748–1799," Vol. I, Boston, 1925.

†Guy-Harold Smith, "George Washington at the Great Bend of the Ohio River," Ohio Archeological and Historical Quarterly, Vol. 41, 1932, pp 655–667.

For the next three days, November 6, 7 and 8, the weather conditions go unrecorded. The journal from the 7th to the 16 has been mutilated along the edges, so his record is incomplete and can be interpreted only by considerable interpolation. The 8th of November must have been a fine day for Washington, Crawford and an Indian guide explored the hills above the mouth of the Little Kanawha and that night camped about a mile below the mouth of the Muskingum. His entry for the 9th begins with "The Night prooving very Rainy, and Morning wet we did not set out till ½ after 10 Oclock . . ." Nearly all of his entry for Saturday, November 10th was devoted to the weather. He wrote, "After a Nig[ht] of incessant Thunder and Lig[ht]ning, attended with heavy [con-] stant Rain till 11 Oclock [that] day, we set of about Twelve (the Rain then ceasing) and [came] to the lower end of the long [reach]* distant about 12 Miles—little stream, imperceptable [to] the view in our passage [down but] now pouring in her mite, ... River raising very fast [and] grows so muddy as to ren[der] the water irksome to drink" The "incessant thunder" was a little late in the season, but not an unusual occurrence. It indicates that the temperatures were not unseasonably cold, and perhaps a little above normal.

The stormy weather continued, impeding Washington's upstream journey. For Sunday November 11th he wrote that, "The last Night proved a Night of incessant Rain attended with thunder and lightning. The River by this Morning had raisd abt . . . feet perpendicular and was [trav]elling fast. The rain seeming [to] abate a little, and the wind spring[ing] up in our favor we were [te]mped to set of; but were deceived [in] both; for the Wind soon ceasd, and [the] Rain continued without inter[mis]sion till about 4 Oclock when it moderated." In spite of the rain they got to the head of the long reach, but the stormy weather and the strong current made upstream travel very slow and arduous.

The stormy weather continued yet another night. On the 12th he recorded that "There fell a little [rain] in the Night tho nothing to [speak] of." The river was so swift that Washington gave up trying to paddle the canoe all the way to Fort Pitt, and on the next day sent a young Indian

*The word "reach" is supplied by the present writer for it was on this date that Washington and his party had arrived at the sixteen mile section of the Ohio River commonly known as the "long reach."

to bring their horses to Mingo Town, two miles below the modern Steubenville. At Mingo Town he had to wait three days for the horses to arrive, but on the afternoon of the 20th the party set out for Fort Pitt which they reached the following day.

During the period from November 13 to 23 inclusive Washington made no direct statement about the weather. He does state that the level of the river was falling on the 17th, so we may conclude that the rainy spell was over.

It was on the 23 of November that he set out on his journey from Fort Pitt to Mt. Vernon. The next day he arrived at Captain Crawford's, and his brief entry for that date is concluded by the expression, " . . . it either Raining or Snowing hard all day." It is to be expected that snow might fall in the Allegheny plateau of southwestern Pennsylvania in the latter part of November.

On Sunday, November 25 Washington continued his journey and set out early to visit Lund Washington. He made no definite statement about the weather but noted that " . . . the Ground and trees being coverd with Snow . . . " he was unable to form a distinct opinion of the quality of the land. On the 26th he recorded that "The Snow upon the Alligany Mountains was near knee deep." It is clear that snow in considerable quantity had come early to the highlands of the Allegheny Mountains. Here where Washington found the snow nearly a foot deep toward the end of November the average date of the first killing frost* of autumn is about October 1. It is not an uncommon occurrence to have snow in the higher parts of the plateau any time during the month of November, so the weather experienced by Washington was not unseasonably cold. It is a little unusual, however, to have a foot of snow by the 23 of November.

Washington required five more days to reach home arriving at Mt. Vernon on December 1, 1770. He had been gone just four days short of two months, and during that time had made his most western journey into the heart of North America and travelled altogether a distance of nearly 1000 miles. His weather records for this period indicate that the autumn of 1770 probably was characterized by fairly typical cyclonic storms which brought a snow squall to tidewater Virginia the first of October. During that month probably a half dozen

*Reed, Op. cit., p. 35.

distinct cyclonic disturbances can be identified and their movements determined with some degree of accuracy.

Washington certainly had very little systematic knowledge of the passing weather, but his empirical descriptions make it possible to interpret and explain the meteorological phenomena in terms of the modern knowledge of the science of the atmosphere. The well developed cyclonic storms, the origin of which we are not certain but the nature of which we know much more, brought to Washington and his party changeable autumn weather. He faithfully recorded his observations and these now serve as documentary source material for the study of historical meteorology.

The Social Life of Plants.

Although the name was coined in 1896, the term "plant sociology" may arouse some new concepts in the minds of those who have not been accustomed to consider plant life in terms of communities or social units. The original German text, "Pflanzensoziologie," which appeared in 1928, has been entirely translated, revised, and edited with the addition of considerable new material.

Part I consists of a single chapter on "Social Life Among Plants." Part II contains three chapters on the organization of plant communities. The selection of sample plots for study and the statistical analysis of plant communities are some of the important topics discussed. Methods are given for the determination of abundance, cover, space, and weight of species concerned, as well as such characteristics as sociability, periodicity, frequency, constancy, and fidelity of species. The technical sense in which these terms are applied to plant communities is explained in the text.

Part III includes eight chapters (more than half of the entire book), which discuss the general subject of synecology or "community economics." Here there is an attempt to "search for the underlying causes of the social union and the mutual dependence of the component plants." Factors of climate, soil, topography, and the activities of man and grazing animals, as they affect plant communities, are extensively treated. There is much illustrative material from the works of European and American investigators. Practical methods devised for field use are described in this section of the book.

Parts IV, V, and VI consist of the final three chapters on the development, distribution, and classification of plant communities respectively. An extensive bibliography and index complete the volume. Halftones and line drawings are clear cut and are well-chosen to present data in graphic form.

The use of such terms as "Quercetum" for oak forest and "therophytes" for annual plants show that the author and the translators have accepted European systems of nomenclature for plant communities and life forms. With such a terminology, books and papers on plant sociology appear as difficult reading for the general botanist as the literature on psychiatry must appear to the general practitioner of medicine. Perhaps it is a sign of progress in a science when its language becomes more cumbersome.—R. B. GORDON.

Plant Sociology, by J. Braun-Blanquet. Translated, revised, and edited by G. D. Fuller and H. S. Conard. XVIII — 439 pp., 180 figs. McGraw-Hill Book Co., 1932.

NOTES ON ANOTHER PENNSYLVANIAN FOOTPRINT FROM OHIO.

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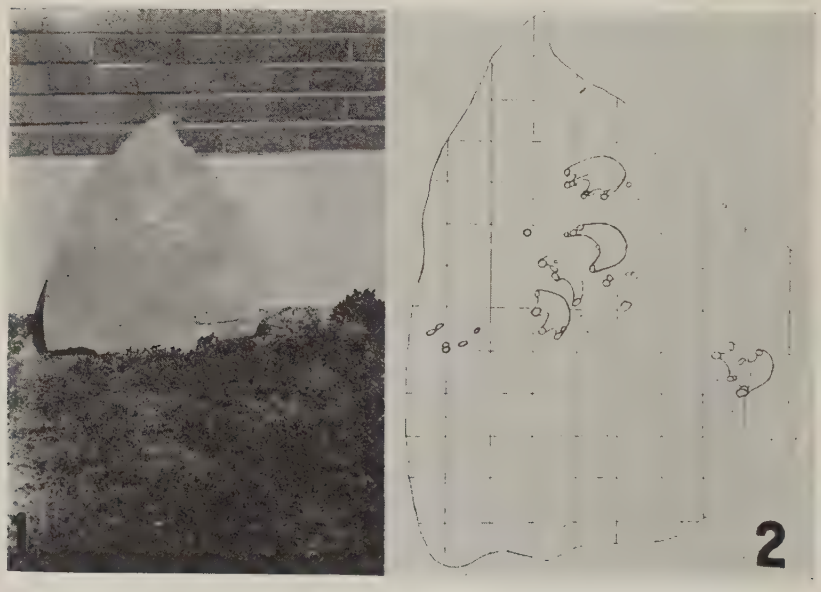
At the 1931 meeting of the Ohio Academy of Science at Oxford, Ohio, a paper entitled "Fossil Footprints from the Pennsylvanian of Ohio" was presented and subsequently published (1). The paper described the finding of "a remarkable number of fossil footprints all apparently made by the same type of animal," in the Cleveland mine of the Cambridge



Collieries at Senecaville, Guernsey County, Ohio. These tracks were identified as those of *Ancylopus ortoni* Carman. Since they were found in the shale above the Upper Freeport coal this was a new locality for *Ancylopus ortoni*. "The striking thing about this locality is the great abundance of tracks, all apparently made by the same type of animal."

Since the publication of the paper a slab which was obtained from the same locality and which is now in the collection of

Muskingum College has been found to show another type of track. This slab is 19 x 24 inches and shows 9 tracks or parts of tracks. (Figure 1.) The tracks consist mainly of what seems to be prints of the ends of the toes and in some cases a broad shallow imprint of the heel as is shown in Figure 2, which is a scale drawing of the slab. The heel prints are seen best on what appears to be the pes. The prints show that the animal which made them had a plantigrade foot with five toes.

Unfortunately, these tracks are not well preserved and absolute identification is impossible from this slab. A careful study has shown a close resemblance to *Baropus hainesi* Carman (2) and it is quite probable that the prints were made by that animal. If this identification is correct this is a new locality both geographically and geologically for *Baropus hainesi*, the original tracks being found in the Pennsylvanian system, Monongahela formation beneath the Benwood limestone in Center Township, Morgan County, Ohio.

As far as the writer knows these are the only tracks other than *Ancylopus ortoni* from this locality. While search is being made for other tracks of this nature with the hope of positive identification, it was thought advisable, in the light of the new finding, to supplement the previous publication and bring it up to date.

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All About Chromosomes.

This is by far the most complete discussion of chromosomes and their importance in evolution to appear in recent literature. It is fascinatingly written, and is authoritative as well, coming from the pen of one who has published continuously on genetics since the beginning of the century. The normal behavior of chromosomes, the localization and mapping of genes, the translocations and deficiencies of genes, the abnormal behavior of chromosomes and the formation of polyploid species and varieties are all discussed in a most interesting and readable style. The choice of illustrations is to be especially commended, each topic being illustrated from the original sources in the fullest possible manner. The recent work on experimental mutations and transmutations is discussed, and the gene as the basis of life and evolution is investigated. A chapter is given to the question of genes in the protozoa. In all, the book is a worthy and necessary addition to any scientific library.—L. H. S.

The Mechanism of Creative Evolution, by C. C. Hurst. xxi + 365 pp. Cambridge, at the University Press (In U. S. A., The Macmillan Co.), 1932.

THE INHERITANCE OF ISO-HEMAGGLUTINOGENS IN RABBITS.

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The search for true blood groups in animals, corresponding to the four orthodox groups in man, has not met with much success. (Snyder, 1926, 1929). In 1929, however, it was independently discovered by Levine and Landsteiner and by Fischer and Klinkhart that the blood of rabbits may possess agglutinogens for which no normal agglutinins occur. Immune agglutinins may be produced for these, however. When such immune agglutinins are produced, it is possible to separate rabbits into groups according to whether or not they possess a particular agglutinogen.

The two agglutinogens discovered by Levine and Landsteiner, and Fischer and Klinkhart, respectively, were found on comparison not to be identical. Thus, some rabbits possess both agglutinogens, some only one, some the other, and some possess neither. On this basis rabbits are of four groups.

The inheritance of these groups becomes at once of interest to the genetecist. Many genetic characters are known in rabbits, and the occurrence of a new factor makes possible the extension of linkage results. Rabbits of known group were accordingly sent by Landsteiner to Castle for genetic study. It was suggested by Castle that we cooperate in the work, the final plan being to produce the Fischer serum at Ohio State and study its agglutinogen at that institution, and to produce the Landsteiner serum at Harvard and study its agglutinogen there. In 1930 we received at the Genetics Laboratory of the Ohio State University five rabbits, two of them known to contain the Fischer agglutinogen (i.e., positive), and three known not to contain it (negative).

Our first task was to obtain a diagnostic serum. With the kind assistance of Dr. C. A. Doan we were able to produce a strong agglutinin by immunization. The method used was as follows.

Aseptic technic was used throughout. Nine cc. of blood were withdrawn from the heart of the donor (known to be

positive) into a syringe containing 1 cc. of 5 percent sodium citrate in normal saline. The donor was not anaesthetized, but was held on its right side by two assistants. With the rabbit's head at the left of the operator, the heart was located by the operator's thumb, the hair shaved from over the heart, alcohol and iodine applied, and the needle pushed between the ribs. With a little practice the needle can be inserted into the ventricular cavity and blood withdrawn.

TABLE I.

Summary of 77 Families of Rabbits Studied for the Presence (Positive) or Absence (Negative) of an Iso-hemagglutinogen.

Matings	Offspring	
	Positive	Negative
positive	124	15
x	calc. .880	.110
positive	obs. .893	.107
40	dev. .003	.003
positive	85	38
x	calc. .668	.332
negative	obs. .692	.308
33	dev. .024	.024
negative	0	13
x	calc. 0.00	1.00
negative	obs. 0.00	1.00
4	dev. 0.00	0.00

The citrated blood was then injected directly into the marginal ear vein of the recipients (which were negative for the agglutinogen). The 10 cc. of citrated blood were divided among two recipients. Two donors were used alternately. The injections were made every four days until nine had been made.

After the last injection, the serum of the recipients was tested against the red cells of the donors. It was found that a strong agglutinin had been produced in the serum of the recipients. Fourteen days after the last injection, the recipients were exsanguinated, and the serum prepared and stored with a preservative.

It was then possible to test all our available rabbits for the presence or absence of the agglutinogen. A drop of a washed suspension of red cells was mixed with a drop of test serum on a slide, in a manner similar to the test for the human blood groups. The slides were examined at the end of a few minutes, and again at the end of an hour in the incubator.

In all 504 rabbits were tested; of these 379, or 75.1% were positive, and 125, or 24.9% were negative. Of these 504 rabbits, 429 were studied from the standpoint of heredity. They comprised 77 families of parents and offspring. The results of this study are given in Table I.

The agglutinogen appears to be a dominant unit character. It is seen, however, that the observed numbers of negative offspring in the crosses of positive with positive, and positive with negative, are slightly less than the calculated results. This suggests the possibility of another allelomorph.

The calculated results were obtained by the formulae

$$\left(\frac{q}{p+2q}\right)^2 \text{ and } \frac{q}{p+2q}$$

as developed by Snyder (1932). In the case of this agglutinogen, letting H stand for the factor producing the agglutinogen and h for its absence, and setting p as the frequency of H and q as the frequency of h, p = .502, and q = .498.

It can readily be shown that the above formulae will give the expected results if only two allelomorphs are concerned, but will give results somewhat higher than those to be expected if three allelomorphs exist. Thus in the four human blood groups, assuming that only two groups, A and O, are known (in which case group AB would be included with A, and B with O),

Let p = frequency of A
and q = frequency of O
$p^2 + 2pq$ = group A
q^2 = group O
$q = \sqrt{O}$

Since the real group O occurs with a percentage of 45 in the American population, and group with B a percentage of 10, our supposed group O will here be .45 + .10. Then

$q = \sqrt{.55} = .741$
$p = 1 - q = .259$

When, however, the four groups are actually known, due to three allelomorphs A, B and O, we may let p = frequency of A, q = frequency of B, and r = frequency of O. Then p + r, dealing with the frequencies of the factors concerned in groups A and O, will be less than 1. The derivation of p, q and r has been dealt with in previous publications (Snyder 1926, 1929 etc.).

Let R = % recessives expected in matings of A with A when only two groups, A and O, are known,

And let R^1 = % recessives expected when four groups are actually known.

Let S = % recessives expected in matings of A with O when only two groups are known,

and let S^1 = % recessives expected when four groups are known.

$$\text{Then } R = \left(\frac{q}{p + 2q}\right)^2$$

$$R^1 = \left(\frac{r}{p + 2r}\right)^2$$

$$S = \frac{q}{p + 2q}$$

$$S^1 = \frac{r}{p + 2r}$$

These formulae may be applied to the known proportions of the four blood groups and the derived frequencies of the genes in man. Using Americans and Koreans, as representing two races where the allelomorph B is low and high, respectively, the results are as given in Table II.

TABLE II.

Comparison of Proportion of Recessive Offspring to be Expected in Various Matings When Only Two of Three Allelomorphs are Known, and When all Three are Known.

	Americans	Koreans
R	.180	.190
R^1	.175	.173
S	.425	.436
S^1	.419	.416

It is seen that when only two allelomorphs are known of a series containing more than two, the recessive offspring observed in matings of dominant with dominant, and dominant with recessive, will be less than that calculated on the basis of two allelomorphs. We find this condition to exist in our results. While the differences are small, they are both in the same direction, and only a small difference is to be expected.

Inasmuch as Castle and Keeler are investigating the Landsteiner agglutinogen, and tell us that they find it to be due to a dominant factor similar to the one producing the Fischer agglutinogen, (Castle and Keeler, in press) we predict on the basis of our calculated results that the two will be found to be allelomorphs, forming with the recessive factor producing neither substance, a series of three allelomorphs, and thus four groups.

We have sent samples of our serum to Castle and Keeler for such a study, with the suggestion that matings between double positives and double negatives be especially examined as giving critical evidence on this point. Their results will be separately published.

We have also made numerous experiments on guinea-pigs, using a wide variety of donors and recipients, but have thus far been unable to demonstrate the presence of any agglutinogen in the red cells. These experiments are being continued.

Summary.

1. The presence of an iso-hemagglutinogen in rabbits, originally discovered by Fischer and Klinkhart, behaves as a unit factor dominant over its absence.

2. The comparison of observed and calculated proportions of recessives in various types of matings leads us to predict the presence of a third allelomorph in the series, presumably the gene for the presence of the agglutinogen discovered by Levine and Landsteiner. This possibility is being investigated by Castle and Keeler as part of a cooperative project.

3. Attempts to demonstrate the presence of iso-hemagglutinogens in guinea pigs have thus far been unsuccessful.

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SOME NEW SPECIES OF EUGNATHODUS. (HOMOPTERA CICADELLIDAE).

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Ohio State University.

Eugnathodus Baker.

The genus *Eugnathodus* was erected in 1903 by Baker at which time *E. abdominalis* V. D. was cited as the type. From the description of the genus it is apparent Baker had in hand specimens of the species which we have since identified as E. *abdominalis* but which is given the name of *E. neglecta* in this paper. An examination of the type specimens of *E. abdominalis* has revealed the fact that they are specimens of *Balclutha* and it is apparent Baker cited this type in error. The type of *Eugnathodus* as described by Baker is therefore designated as *neglecta* Del & Dav.

This genus differs from *Balclutha* in having the vertex broadly rounded, almost parallel, margined, only slightly produced before the anterior margins of the eyes, and head broader than pronotum.

A forthcoming paper will deal with the species of this genus and *Balclutha* but in order that other workers may use these names in citing these species in other papers, the following descriptions are presented at this time.

Eugnathodus neglecta n. sp.

Usually pale or dark brownish in color with blunt head and distinct genitalia. Length, 3.5 mm.

Vertex almost four times as wide as long, broadly rounded, almost parallel margined. Pronotum three times as long as vertex.

Color pale to dark brown, often with rather conspicuous markings on vertex pronotum and scutellum. Elytra smoky to white.

Genitalia: Female last ventral segment with posterior margin slightly emarginate either side of a central slightly produced median tooth which is inconspicuous. Posterior margin narrowly embrowned. Male valve rounded posteriorly, plates triangular, about half as wide at base as long. Pygofers exceeding plates. Oedagus in lateral view rather heavy at base, anterior process extending dorsally, arising not far from the point of union with the connective. Body of oedagus extending caudally, tapered and extending dorsally and slightly posteriorly. Terminal portion about twice the length of the anterior process.

The species has been designated for many years as *Eugnathodus abdominalis* V. D., but examination of the type specimens have shown this to be a *Balclutha* and the species previously identified as *B. impicta* V. D. Also the species previously identified as *B. impicta* are pale specimen of *B. punctata*.

This species is very common and wide spread and occurs in many areas.

Described from a large series of specimens from several widely separated localities. Specimens have been examined and male genital characters checked for the following localities: Alturas Lake and Stanley Basin, Idaho; Glacier Park, Montana; Springer, Mesilla Park and Raton, N. Mex.; Tempe and Tuscon, Arizona; Tower City, N. D.; San Antonio, Paris and Brownville, Texas; Lincoln, Nebraska; Decatur, Ga.; Orlanda, Fla.; Rocky Ford and Mt. Manitou, Colorado.

Male holotype, Mt. Manitou, Colorado. Female allotype from same locality and male and female paratypes in author's collection. Paratypes in collection of U. S. National Museum and personal collections of Herbert Osborn and E. D. Ball.

Eugnathodus neglecta variety **pallida** n. var.

Form and general appearance of *neglecta*, but pale green or white in color. Length, 3 to 3.5 mm.

Structural and genital characters as in *neglecta*.

Color pale green or yellow, often appearing milk white. Disc of pronotum sometimes slightly darker. Dorsal portion of abdomen black or dark brown. Elytra whitish subhyaline unmarked.

Described from a series of specimens from Clarksville, Tennessee, collected during July and August, 1915, by the senior author.

This may be a separate species but cannot be distinguished on the basis of structural characters.

Eugnathodus floridana, n. sp.

Resembling *neglecta* in general appearance; pale green and with distinct genitalia. Length, 3 mm.

Vertex three times as wide as long and one-third as long as pronotum. Elytra produced one-third their length beyond apex of abdomen.

Color: Pale green marked with yellow. Elytra whitish subhyaline, veins white, claval area yellowish.

Genitalia: Female last ventral segment long, posterior margin roundedly produced, appearing to be notched at middle. Male genital

pieces with styles in ventral view broad at base, strongly narrowed to finger-like pointed apices which are divergent. Outer margin of style heavily chitinized on central portion and curved downward. Connective of oedagus more deeply notched at base than other species. Oedagus in lateral view thick at base with anterior portion extended, slightly forward, upward and then directed posteriorly. Body of oedagus extending dorsally and curving anteriorly into preceding segment.

Described from two female and one male specimens collected at La Belle, Florida, April 20 and 21, 1921 by the senior author. Holotype male La Belle, Florida, April 21, 1921. Allotype female and female paratype in collection of senior author.

Eugnathodus abbreviata n. sp.

Short and robust, pale yellow in color and with distinct genitalia. Length, 2.5 mm.

Vertex broadly rounded more than three times as wide as long. Produced two-thirds its length before anterior margins of the eyes. Pronotum three times as long as vertex.

Color: Pale yellow or white washed with bright yellow. Eyes usually dark brown. Elytra whitish subhyaline, claval area washed with yellow.

Genitalia: Female last ventral segment slightly produced and sinuate either side of a slightly produced median tooth-like portion. Male valve short and rather broad. Plates about one and one-half times as long as broad, apices blunt. Styles in ventral view rather long, wide at base, triangular, rather abruptly narrowed to divergent finger-like tips. Oedagus in lateral view with a long thick finger-like portion at base extending dorsally. Body of oedagus long and curved extending dorsally and with apex directed anteriorly.

The pale yellow color of this species and the distinct genital character of the male will easily distinguish it from the other species of the genus.

Described from a series of some seventy specimens, mostly females, collected at Belle Glade, Florida, during the summer of 1929 by Mr. Hugh Clifton. Holotype male, allotype female, and male and female paratypes in collection of senior author. Female paratypes in U. S. National Museum collection.

Eugnathodus calcara n. sp.

Resembling *neglecta* in form, size and appearance, but distinguished by the male genital characters and a large spine on the pygofers. Length, 3.5 mm.

Vertex broadly rounded three and one-half times as wide as long, produced about one-half its length before anterior margins of eyes.

Color: White to dull gray, vertex, anterior portion of pronotum and basal angles of scutellum ferruginous to yellow. Elytra white, venation white.

Genitalia: Male styles broad at base, concave inwardly on basal margin, tapered toward apex. Conspicuously, abruptly notched toward base on outer margin forming a thick finger-like apical process which curves outwardly from inner margin. Connective broad at base and broadly shallowly notched. Oedagus in lateral view thick at base with anterior basal process directed dorsally and anteriorly. Posterior portion extending into a long whip-like process which is gradually narrowed and directed dorsally and anteriorly at apex. Pygofers of male with a heavily chitinized spur arising at the ventral caudal portion and curving upwardly and inwardly into the genital chamber.

Described from two male specimens collected at Miami, Florida, April 14, 1921, by the senior author. Holotype male and paratype male, Miami, Florida, April 14, 1921, in collection of senior author.

The species can easily be distinguished from all others of the genus by the heavy spur on the pygofer.

Eugnathodus bifurcata n. sp.

In general appearance resembling *neglecta*, but with distinct male genitalia and a bifurcate spine on the pygofer. Length, 3.5 mm.

Vertex three and one-half times as wide as long, less than one-third as long as pronotum.

Color: Gray to dull green tinted with yellow, without definite color markings. Eyes usually dark.

Genitalia: Female last ventral segment with posterior margin almost truncate, slightly indented either side of middle. A dark brown color marking on middle of posterior portion causes the segment to appear deeply notched either side of a median broad rounded tooth. The male genital pieces are unique. Style concave inwardly at base, constricted about middle then enlarged to form a pair of finger-like processes by being deeply notched on outer margin. The basal one is heavy and short, the apical one is long and strongly curving outwardly. Oedagus in lateral view rather thick on basal half, without anterior process, terminal half curved and directed anteriorly from erect position of basal portion. Pygofer with a heavily chitinized spine extending into the genital chamber. A short chitinized spur also extends downward from the lower end of the large spine.

Described from a series of three female and four male specimens. The female and three male specimens were collected at Miami, Florida, April 13, and 14, 1921 and one male specimen at Paradise Key, Florida, April 5, 1921, all by the senior author. Holotype male, allotype female, and male and female paratypes in collection of senior author.

CICADELLIDAE LEAFHOPPERS OF NEW HAMPSHIRE.*

PHILIP ROSEMOND LOWRY.

The Cicadellidae of Certain Plant Associations in New Hampshire.

From 1921 to 1927 the author has made frequent collections of Cicadallidae from four distinct ecological associations in the vicinity of Durham, N. H. Those collections cover the whole year and represent a rather complete census of the leafhopper fauna of these associations. After some study, representative areas were selected in each of the associations and the work was concentrated on these. None of the areas are over 2.5 miles from tide water, or over 100 feet above sea level.

Gray's *Manual of Botany* is followed for the plant names. The author is indebted to the late Dr. Mabel M. Brown for assistance in plant determinations.

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*The studies of the leafhoppers of New Hampshire undertaken several years ago by Mr. Lowry contemplated extensive collections and habitat studies with faunistic comparisons of adjacent regions and with a view to use it as a doctorate dissertation in the Department of Entomology at the Ohio State University, of which Mr. Lowry was a graduate, receiving the Bachelor of Science degree in 1920 and Master of Science in 1921. He had made extensive collections and careful studies of certain ecologic regions with an exhaustive comparison of the New Hampshire fauna with that of adjacent territory, with the hope of early completion of the work which was interrupted by his untimely death, April 29, 1931.

In this work he had the advantage of correspondence and assistance from a number of specialists who will be found credited for certain help in the paper. After his death the notes were submitted to the writers for the purpose of assembling the available material for publication and there has been an effort to include so far as possible all of the records and discussion which had been carried to such a point as to be suitable for permanent record. For the most part the exact data as recorded by Mr. Lowry have been indicated with certain condensations to avoid duplication of records and locality citations and with indication by initials of the collectors he had given credit for specific records. The discussion of plant associations is presented in essentially the form in which the notes had been written up by Mr. Lowry and will be found to contain numerous valuable indications of ecological distribution for these insects. There can be no question that had Mr. Lowry lived to complete the study he would have prepared a most valuable contribution, especially with reference to ecological relations of the leafhoppers of the New England region as the notes and discussion of related faunae which had not been digested and written up in form for publication would certainly have added much to the material presented here.

The collecting was performed for the most part in the vicinity of Durham, N. H., and in the White Mountain region, consequently most of the records are from southern New Hampshire.

Herbert Osborn and Dwight M. DeLong.

SALT MARSH.

This is a small salt marsh in an inlet of Great Bay, which is, at low tide, about half muck flat and half true marsh. A small tidal creek flows through the marsh, in which grow large masses of eel grass, *Zostera marina* L. and scattered sea lettuce, *Ulva*. *Fucus vesiculosus* grows in masses on a few rock masses projecting into the stream. Salt marsh grass, *Spartina glabra* Muhl. borders the stream and practically covers the muck flats with a pure stand. Most of the *Spartina* is partially submerged at high tide. Above the reach of ordinary tides, salt meadow grass, *Distichlis spicata* (L.), covers most of the area and mixed with it are clumps of black grass, *Juncus gerardi* Loisel. Scattered plants of the following species are also present: *Salicornia europaea* L., sea lavender, *Limonium carolinianum* (Walt.) Britton, seaside plantain, *Plantago decipiens* Barneoud, and toward the outer edge of the area, seaside goldenrod, *Solidago sempervirens* L. and *Spartina patens*, probably var. *caespitosa* (Eaton) Hitchc.

Surrounding the marsh are rough, bushy pastures and young, scrubby, mixed pine and hardwood stands.

The leafhoppers typical of this association are *Deltocephalus littoralis* Ball, rare on *Distichlis; Deltocephalus simplex* V. D. and *Hecalus lineatus* (Uhl.), both fairly common on *Spartina*, although the latter species is found inland on *Spartina*. Species collected in New Hampshire from this association only, but reported from other associations, are *Phlepsius ramosus* Baker and *Phlepsius fuscipennis* V. D., both rare on *Spartina patens*, and *Thamnotettix fitchii* V. D., rare on *Spartina glabra*. Other widely distributed species collected are *Draeculacephala mollipes* (Say) and *D. noveboracensis* (Fitch) often abundant; *Deltocephalus pascuellus* (Fall.), *Thamnotettix melanogaster* (Prov.), *Chlorotettix unicolor* Fitch and *Dikraneura fieberi* (Loew) fairly common; and *Gyponana octolineata* var. *striata* Burm., *Thamnotettix decipiens* Prov., *Cicadula sexnotata* (Fall.), *Platymetopius acutus* (Say) and *Euscelis cuneatus* S. & DeL. uncommon.

BOG.

This area is a small, but typical bog, surrounded on all sides by steep hills and known locally as "Spruce Hole." In the center is an open pond, advancing into which are leather leaf, *Chamaedaphne calyculata* and a sedge. Around the pond is a

zone containing the following: *Sphagnum*, leather leaf, cotton grass, *Eriophorum;* pitcher plant, *Sarracenia purpurea;* a sedge, round leaved sundew, *Drosera rotundifolia;* cranberry, *Vaccinium macrocarpon;* small plants of sheep laurel, *Kalmia angustifolia*, and pale laurel, *Kalmia palifolia*. Outside of this is a second zone in which the shrubs are large and have become dominant. The plants are the same, but the relative proportions have changed and there is in addition blueberry, *Vaccinium corymbosum;* small black spruce, *Picea mariana;* checkerberry, *Gaultheria procumbens*, and a fine, low sedge. Entirely surrounding the bog is a narrow third zone of close growing black spruce, 10 to 30 feet high, and growing among them creeping snowberry *Chiogenes hispidula*, goldthread *Coptis trifolia*, mosses and remnants of the preceding vegetation. Several cicadellids are characteristic of this association. *Cicadula pallida* Osb. common on sedge, *Euscelis striatulus* (Fall.) common on blueberry and *Euscelis humidus* (Osb.) not uncommon on blueberry, are confined to bogs in New Hampshire. *Platymetopius magdalensis* Prov. and its variety *cinnamoneus* Osb. common on blueberry, *Platymetopius fulvus* Osb. not common on blueberry, and *Erythroneura obliqua* var. ——— rare on sheep laurel, are regular inhabitants of bogs but have also been found on the same hosts in other associations. Other widespread species collected, of which *E. obliqua* is the commonest are: *Gyponana* var. *octolineata* var. *striata* Burm., *Scaphoidus productus* Osb., *Phlepsius collitus* Ball, *Thamnotettix decipiens* Prov., *Jassus olitorius* Say, *Balclutha punctata* (Thun.), *Dikraneura fieberi* (Loew), *Erythroneura obliqua* (Say) and its varieties *noevus* (Gill.) and *fumida* (Gill.) and *Erythroneura maculata* (Gill.). *Oncopsis sobrius* (Walk.) was taken rarely, but is probably a stray from surrounding birches.

WHITE PINE–HEMLOCK FOREST.

This lies in the University forest which consists of about 50 acres of old growth white pine and hemlock. The area studied is almost entirely made up of large trees of *Pinus strobus* and *Tsuga canadensis*, with an occasional *Betula lenta* or *Fagus grandifolia*. Where the stand is undisturbed there is little undergrowth, the commonest plant being *Mitchella repens*. In small openings caused by windfalls, there is a rich flora, of which the following, representing a little over half the species observed are the most important:

Small Trees and Seedlings.
Betula leuta.
Tsuga canadensis.
Pinus strobus.
Fagus grandifolia.
Acer rubrum.
Quercus alba.
Quercus rubra.
Tilia americana.
Fraxinus americana.
Acer saccharum.
Betula lutea.

Shrubs.
Taxus canadensis.
Lonicera canadensis.
Corylus rostrata.
Rubus triflorus.
Rubus idaens acuteatissimus.
Rubus.
Diervilla lonicera.
Cornus alternifolia.
Viburnum acerifolium.
Viburnum dentatum.

Herbs.
Polypodium vulgara.
Phegopteris dryopteris.
Polystichum acrostichoides.
Aspidium spinulosum intermedium.
Lycopodium lucidulum.
Lycopodium clavatum.
Lycopodium obscurum.
Lycopodium complanatum.
Clintonia borealis.
Smilacina racemosa.
Oakesia sessilifolia.
Epipactis pubescens.
Hepatica triloba.
Maianthemum canadense.
Anemone quinquefolia.
Coptis trifolia.
Aralia nudicaulis.
Chimaphila umbellata.
Cornus canadensis.
Pyrola chlorantha.
Pyrola elliptica.
Monotropa uniflora.
Gaultheria procumbens.
Trientalis americana.
Mitchella borealis americana.
Epigaea repens.
Aster acuminatus.
Aster, spp.
Solidago, spp.

In addition there are scattered bunches of grasses and sedges and the drier spots often have *Cypripedium acaule.* In a single quite moist, open area is found *Sambucus racemosa*, *Rubus hispidus*, *Impatiens biflora*, *Viola incognita* and *Viola conspersa.*

This seems to be a temporary climax in this region. In the deeper, moist, richer soil a mixed stand occurs with a high percentage of hardwoods which is probably the true climax. The ground cover is dominated by herbs and shrubs of the northeast evergreen forest type. The common occurrence of many southern forms over this region is probably due to invasions following the settling and clearing of the country.

Leafhoppers are not particularly abundant in this association, the vegetation in the openings yielding most of them.

Thamnotettix belli (Uhl.) and its variety *brunneus* Osb. rare on shrubs and *Eupteryx vanduzei* Gill. not uncommon on wood fern, have been taken in New Hampshire in this association only. *Pagaronia tripunctata* Fitch, common on *Mitchella*, and *Thamnotettix morsei* Osb. rare on shrubs (oak?) are more common here than elsewhere in New Hampshire. All the remaining species taken are common and widespread, as numerous or more so, in other associations. *Oncopsis variabilis* (Fitch), *Oncopsis sobrius* (Walk.) and *Empoasca* sp. were fairly common on sweet birch. *Eupteryx flavoscuta* Gill. and

its varieties *juvenis* McA., *clavalis* McA. and *nigra* Osb. were common on wood fern, as were also nymphs and adults of *Graphocephala coccinea* (Forst.). The adults of the latter species were also common on other shrubs and herbs. *Platymetopius magdalensis* Prov. was rare on *Vaccinium pennsylvanicum*. *Cicadula slossoni* V. D. was common on *Impatiens*. The following species were taken on grasses and sedges: *Agallia novella* (Say) and *Balclutha punctata* (Thun.) fairly common, *Dikraneura fieberi*, rare, *Agallia 4-punctata* (Prov.) and *Cicadula sexnotata* (Fall.) not common, and *Chlorotettix balli* Osb. rare. General sweeping of herbs and shrubs yielded the following: *Scaphoideus productus* Osb., *Erythroneura maculata* Gill., *Erythroneura obliqua* (Say) with its varieties *noevus* (Gill.), *fumida* (Gill.) and *parma* McA., common; *Scaphoideus auronitens* Prov., *Scaphoideus scalaris* V. D., *Scaphoideus immistus* Say, *Gyponana octolineata striata* Burm. and *Thamnotettix kenicotti* (Uhl.) fairly common; *Platymetopius acutus* (Say), *Jassus olitorius* Say, *Empoasca birdii* Goding, *Mesamia vitellina* (Fitch) and *Erythroneura comes* var. *vitifex* Fitch and variety *rubra* (Gill.) rather rare.

DRY, SANDY UPLANDS.

This area is a level, well drained glacial outwash with very sandy, dry soil. The whole area is covered with clumps of *Andropogon scoparius* and irregularly scattered throughout are pitch pines, *Pinus rigida*, from one to thirty feet high, occurring in groups or singly. There are also a few small, scattered gray birch, *Betula populifolia* and white pine, *Pinus strobus*. Scattered through the dominant *Andropogon* are the following: *Aristida gracilis*, *Rubus villosus*, *Potentilla pumila*, *Aster linariifolius*, *Aster* sp., *Solidago* two spp., a sedge, *Potentilla argentea*, *Lysimachia quadrifolia*, *Rumex acetosella*, *Hypericum perforatum*, *Antennaria canadensis*, *Fragaria virginiana*, reindeer moss (*Cladonia*).

Complete clearing, and cultivation, followed by periodical fires, probably account for this type of association. This is a xerophytic association of high temperature and having both prairie and heath aspects. A number of southern and prairie leafhoppers are restricted to this association in New Hampshire or are found in greatest numbers here.

At the edges of the area the dewberry increases, *Myrica asplenifolia* is common, and the following appear: *Pteris aquilina*, *Rhus copallina* and *Vaccinium vacillans*.

The following have been collected from the pitch pine: *Paracoelidea tuberculata* Baker, abundant, *Phlepsius graniticus* O. & L. and *Platymetopius angustatus* Osb., common, *Thamnotettix* n. sp. (near *perspicillatus*), rare, and *Gyponana octolineata tenella* Spbg., rare. The foregoing have been taken on this host only. *Empoasca coccinea* (Fitch) is common, but occurs on other pines elsewhere. *Phlepsius carolinus* Lathrop and *Phlepsius tullahomi* DeL. are found, but are much more common in the herb stratum. Widespread species not commonly taken are *Mesamia vitellina* (Fitch), *Scaphoideus immistus* (Say) and *Thamnotettix kennicotti* (Uhl.).

The following species have been taken on the *Andropogon* and associated plants: *Deltocephalus sandersi* Osb., abundant on *Andropogon*, *Phlepsius tullahomi* DeL. is common, *Parabolocratus flavidus* Sign. is fairly common, *Prairiana cinerea kansana* Ball, *Aligia modesta* (O. & B.) and *Deltocephalus caperatus* Ball are rare. All the above have been taken in New Hampshire in this association only. The following are commonest in this association in New Hampshire: *Deltocephalus unicoloratus* G. & B., abundant, *Phlepsius carolinus* Lat. and *Acinopterus acuminatus* V. D. fairly common, and *Drioturá gammaroides* (V. D.) rare. The following are of more or less common occurrence: *Deltocephalus melsheimerii* (Fitch), *Deltocephalus configuratus* Uhl., *Deltocephalus misellus* Ball, *Deltocephalus compactus* O. & B., *Deltocephalus sayi* (Fitch) and *Aconura acuticauda* (Baker). Species rarely taken are *Deltocephalus obtectus* O. & B., *Xestocephalus pulicarius* V. D., *Platymetopius acutus* (Say), *Eutettix cinctus* O. & B., *Chlorotettix unicolor* (Fitch) and *Erythroneura maculata* Gill.

ABBREVIATIONS.

The names of collectors credited in the following records are indicated by initials as follows:

E. D. B.—E. D. Ball.
J. C. B.—J. C. Bridwell (N. H. Agr. Exp. Sta. Coll.).
R. A. C.—R. A. Cushman (N. H. Agr. Exp. Sta. Coll., Bost. Soc. Nat. Hist.).
D. M. D.—D. M. DeLong.
W. F. F.—W. F. Fiske (N. H. Agr. Exp. Sta. Coll.).
C. W. J.—C. W. Johnson (Bost. Soc. Nat. Hist.).
J. C. K.—J. C. Kendall (N. H. Agr. Exp. Sta. Coll.).
W. L. M.—W. L. McAtee.
A. T. S.—Mrs. Annie Trumbull Slosson.
J. S.—J. Smith (N. H. Agr. Exp. Sta. Coll.).
M. J. S.—M. J. Smith (Woodman Institute Coll.).
L. W. S.—L. W. Swett?

RECORDS OF COLLECTIONS

Agallia novella (Say). Dover, July 19, 1922; Durham, June 5, 29, July 7, 8, 14, August 27, 1922, June 23, July 18, August 11, 1923, May 14, 1924, May 16, June 12, 1925; Franconia, August 2, 1930; Hill, July 23, 1923; Mt. Clinton, July 30, 1900 (W. F. F.); Mt. Washington, reported for alpine region at or above 5,500 ft. (A. T. S., 1895), July 4, 1914 (C. W. J.); White Mountains, July 26, 1900 (W. F. F.); Wonalancet, July 17, 1930.

Agallia quadri-punctata (Provancher). Reported for State (O. & B., 1898); Durham, May 26, 1899 (W. F. F.), June 5, 6, July 8, 1922; May 31, June 5, 23, July 2, 1923, June 12, 1925; Hanover, June 8, July 18, 1892 (C. M. W.); Jaffrey, June 15, 1917 (C. W. J.); Mt. Clinton (near summit), July 30, 1900 (W. F. F.); Raymond, July 13, 1930.

Agallia sanguinolenta (Provancher). Dixville, September 9, 1930; Durham, September 8, 13, 22, 30, 1921, March 15, June 5, July 7, 11, 21, August 29, October 2, 5, 1922, May 7, July 18, 27, September 11, 1923; Hill, July 23, 1923; Mt. Washington (summit), September 3, 1925; North Hampton, September 13, 1922; Portsmouth, September 3, 1922; Twin Mountains, July 28, 1900. Common in meadows.

Idiocerus amabilis Ball. Durham, August 19, 1927, from willow, (det. E. D. B.).

Idiocerus pallidus Fitch. Durham, July 9, 1898 (W. F. F.), August 18, 1899 (R. A. C.), September 13, 1921, August 29, September 7, 14, 21, 1922, July 5, 27, 1923; Franconia, August 2, 1930; Hanover, July 28, 1892 (C. M. W.); Hill, July 23, 1923; Mt. Washington, reported for alpine region (A. T. S., 1895); Twin Mountain, July 28, 1900 (W. F. F.); Webster, July 17, 1900 (W. F. F.); Wonalancet, July 17, 1930. Common on willow.

Idiocerus suturalis Fitch. Durham, July 6, 9, 1925; Franconia, August 2, 1930; Lee, September 9, 1928, August 7, 1930; Mt. Washington, reported for alpine region (A. T. S., 1895); reported (O. & B., 1898); Newmarket, July 23, 1930; Rochester, July 10, 1930; Rockingham, August 21, July 7, 1928. On small-toothed aspen.

Idiocerus suturalis var. *lunaris* Ball. Durham, July 6, 9, 1925; Franconia, August 2, 1930; Lee, July 7, 1928; Rochester, July 10, 1930; Rockingham, August 21, July 7, 1928; Twin Mountain, July 28, 1900 (W. F. F.); Webster, July 17, 1900 (W. F. F.). On small-toothed aspen.

Idiocerus suturalis var. *vagus* Ball. Mt. Washington, reported for alpine region (A. T. S., 1908).

Idiocerus duzeei Provancher. Reported for State (O. & B., 1898); Durham, July 23, 1921; Franconia (A. T. S.), reported (O. & B., 1898).

Idiocerus alternatus Fitch. Durham, July 20, 1898 (W. F. F.), April 19, May 16, 1900, July 9, 1923; Franconia (A. T. S.), reported (O. & B., 1898). On willow.

Idiocerus productus Gillette and Baker. Mt. Washington, reported for alpine region (A. T. S., 1906).

Idiocerus formosus Ball. Mt. Washington, reported for alpine region (A. T. S., 1906).

Idiocerus lachrymalis Fitch. Occurs wherever *Populus tremuloides* is present.

Idiocerus provancheri Van Duzee. Isles of Shoals, August 2, 1928 *Pyrus arbutifolia*); Pinnham Notch (Glen House), July 23, 1915 (C. W. J.), July 21, 1922 (J. A. C.); Mt. Monadnock, September 6, 1906; Mt. Washington, reported for alpine region (A. T. S., 1896), (A. T. S.), reported (O. & B., 1898).

Idiocerus fitchi Van Duzee. Durham, July 9, 1899, in trap lantern (W. F. F.); July 20, 22, 1921, July 11, 1922; Nashua, August 11, 1924; Wilton, August 11, 1927. On apple.

Macropsis virescens (Gmelin). Durham, July 2, 5, 9, 27, 1923; Rye, July 25, 1928. Common on willow.

Macropsis virescens var. *graminea* (Fabricius). Durham, July 2, 5, 9, 27, 1923; Rye, July 25, 1928. Common on willow.

Macropsis viridis (Fitch). Durham, July 11, 1898 (W. F. F.), July 11, 1922, June 23, July 5, 9, 27, August 11, 1923; Farmington, July 6, 1923; Franconia, August 2, 1930, on willow.

Macropsis suturalis (Osborn and Ball). Durham, July 5, 27, 1923; Rye, July 25, 1928. On willow.

Macropsis basalis (Van Duzee). Durham, July 8, 1922, July 9, 1923, July 19, 1925; Exeter, July 9, 1925; Lee, August 7, 1930; Wonolancet, June 20, 1930. On small-toothed aspen.

Macropsis basalis var. *fumipennis* Gillette and Baker. Durham, July 19, 1925, on small-toothed aspen.

Macropsis canadensis (Van Duzee). Durham, July 5, 27, 1923. On willow.

Macropsis bifasciata (Van Duzee). Durham, July 9, 27, 1923, July 19, 1925; Exeter, July 9, 1925; Farmington, July 6, 1923; Newmarket, July 23, 1930. On large- and small-toothed aspen.

Macropsis trimaculata (Fitch). Durham, July 26, 1924, common on a few plum trees in Uni. plum orchard; cast nymphal skins found on underside of leaves; no apparent injury to infested trees.

Macropsis sordida (Van Duzee)? Durham, July 6, 1925. On quaking aspen. (Do not fit description, are probably what has been called *sordida* in the East; perhaps a new species.)

Oncopsis variabilis (Fitch). Common on birch. Taken at Alton, Bretton Woods, Crawfords, Durham, Epping, Fabyans, Hill, Mt. Washington, Pinkham Notch.

Oncopsis sobrius (Walker). Durham, July 10, 11, 1898 (W. F. F.), June 5, 1922, July 7, June 23, July 1, 18, 27, 1923; Epping, June 27, 1898 (W. F. F.); Farmington, July 6, 1923; Hanover, July 21, 1892 (C. M. W.); Hill, July 23, 1923; Mt. Washington, (A. T. S., 1894), alpine region at or above 5,500 feet; Osaipee, July 11, 1929; Rye, August 9, 1929. On birch.

Oncopsis cognatus (Van Duzee). Mt. Washington, reported for alpine region (A. T. S., 1902).

Oncopsis fitchi Van Duzee. Alton, July 4, 1927; Mt. Clinton (summit), July 30, 1900 (W. F. F.); (near summit), July 26, 30, 1900 (W. F. F.); Mt. Washington, reported for alpine region (A. T. S., 1896), July 24, 1900 (at base), (W. F. F.); White Mountain (alpine summits of Presidential Range), July 26, 28, 31, 1900 (W. F. F.). On birch.

Oncopsis pruni (Provancher). Durham, July 17, 1898 (W. F. F.), July 7, 8, 18, 21, 1922, July 18, 27, 1923, July 6, 1925; Epping, June 27, 1898 (W. F. F.); Hill, July 23, 1923; Mount Washington, reported (A. T. S., 1894) for alpine region; White Mountains, "subalpine" (Scudder), reported by E. P. Van D., 1890. Common on birch.

Oncopsis minor (Fitch). Reported for State in Van Duzee's Cat.; Jackson, September 18, 1927, on yellow birch.

Oncopsis nigrinasi (Fitch). Durham, July 15, 20, 1898 (W. F. F.), June 24, 1899 (J. C. K.), June 29, July 2, 7, 14, 1922 (R. A. C.), July 9, 1923, July 8, 1928. Common on hop hornbeam.

Oncopsis fagi (Fitch)? Durham, July 20, 1898 (W. F. F.), July 8, 1922. From hornbeam and river beech. (The above two specimens may not be the *fagi* of Fitch, but they are surely a distinct species.)

Oncometopia lateralis (Fabricius). Durham, August 18, 1899 (R. A. C.), September 18, 1921, June 14, 1924, September 4, 1927; Littleton, September 9, 1895 (C. M. W.); Mount Washington, reported (A. T. S., 1894); Nottingham, October 9, 1898 (W. F. F.), September 4, 1927; Pinnham Notch (Glen House), September 22, 1907 (C. W. J.); Twin Mountain, July 28, 1900 (W. F. F.).

Cicadella gothica (Signoret). Common at all localities collected, especially in roadside vegetation.

Cicadella gothica var. *atra* Barber. Durham, September 16, 1921, on wild rose, October 2, 1922.

Kolla bifida (Say). Durham, September 4, 1897 (W. F. F.), August 30, September 1, 8, 14, 23, 26, October 2, 1922, August 1, 11, 1923; Hanover, August 2, 1892, August 18, 1892 (C. M. W.); reported for State (Ball, 1901); Nottingham, September 4, 1927; Portsmouth, September 3, 1922; Webster, August 4, 1898 (W. F. F.); Wonalancet, September 27, 1930. In wet meadows, pastures, grass in low woods and along roadside.

Helochara communis Fitch. Durham, May 26, 1899 (W. F. F.), March 15, sifted from leaves, March 16, 1902 (R. A. C.), September 22, 1921; May 11, September 1, 7, October 2, 5, 1922, May 7, July 27, 1923; Dover, May 15, 1922 (flew into automobile); Littleton, September 9, 1895 (C. M. W.); Mount Washington, reported from alpine region (A. T. S., 1894); North Hampton, September 13, 1922; Nottingham, October 9, 1898 (W. F. F.); Portsmouth, September 3, 1922. Common on swamp grasses and sedges.

Graphocephala coccinea (Forster). Common at all localities collected, especially in undergrowth of woods or along roadsides.

Graphocephala coccinea var. *teliformis* (Walker). Crawfords, July 26, 1900 (W. F. F.), near summit of Mt. Clinton; Durham, July 23, 1921.

Draeculacephala angulifera (Walker). Jefferson, September 18, 1927, in wet woods.

Draeculacephala manitobiana Ball. Durham, September 14, 1921, July 25, 1925; Jefferson, September 18, 1927, in wet meadow.

Draeculacephala mollipes (Say). Common everywhere on grasses and sedges of moist meadows and woods.

Draeculacephala noveboracensis (Fitch). Durham, July 20, 1922, September 1, 21, 1922, July 28, 1924; Hampton, July 16, 1930; Hanover, July 21, 1892; Littleton, September 9, 1895 (C. M. W.); Lee, August 7, 1930; Portsmouth, September 3, 1922. Common on swamp grass.

Pagaronia (*Kolla*) *tripunctata* (Fitch). Durham, September 4, 1897 (W. F. F.), August 30, September 7, 23, October 14, 1922, August 11, 1923; reported for State (E. D. B., 1901). On *Mitchella repens* and *Gaultheria procumbens*.

Evacanthus acuminatus (Fabricius). Fabyans, July 24, 1900 (W. F. F.); Mt. Washington, reported for alpine region (A. T. S., 1902), July 24, 1915 (W. W. J.); Pinkham Notch, Glen House, July 18, 20, 1915 (C. W. J.); White Mountains, July 31, 1900 (W. F. F.); Wonalancet, July 1, 17, 1930.

Penthimia americana Fitch. Durham, May 20, 1898, May 26, 1899 (W. F. F.); Farmington, July 6, 1923; Jaffrey, June 8, 1920 (C. W. J.). on gray birch.

Gyponana octolineata var. *octolineata* Say. Durham, September 14, 1921, August 29, September 7, 1922; Newmarket, November 1, 1897 (J. S.); Nottingham, October 9, 1898 (W. F. F.).

Gyponana octolineata var. *cana* Burmeister. Durham, September 28, 1897, July 7, 1899, trap lantern (W. F. F.), Aug. 9, 1899 (R. A. C.), September 14, 15, 1921; Jackson, Pinnham Notch, September 18, 1927; Mt. Clinton, July 30, 1900 (W. F. F.); Wonalancet, July 17, 1930.

Gyponana octolineata var. *striata* Burmeister. Common in all places where collecting was done, especially in roadside vegetation.

Gyponana octolineata var. *tenella* Spangberg. Durham, August 11, 1923, from pitch pine; Pelham, August 31, 1905 (J. C. B.).

Gyponana rugosa Spangberg. Nottingham, September 4, 1927, from white oak.

Gypona unicolor Stal. Dover, September 16, 1924 (M. J. S.); Durham, August 15, 1899 (R. A. C.), September 8, 1921, September 11, October 3, 1922; Portsmouth, September 3, 1922. From coarse grass in swampy areas.

Prairiana cinerea var. *kansana* Ball. Durham, July 6, 1925 (Det. E. D. B.). From *Andropogon* in sandy area among scattered pitch pines.

Ponana scarlatina var. *scarlatina* Fitch. Durham, June 6, 28, July 9, 12, 1899, from trap lantern (W. F. F.), September 4, 1923, at light in room.

Xerophloea major Baker. Lee, June 28, 1928, from coarse grass on lake shore.

Stroggylocephalus agrestis (Fallen). Mt. Washington, reported from alpine region (A. T. S., 1906).

Acucephalus nervosus (Schrank). Durham, July 10–September 23, 1922, June 23, July 1, 18, August 11, 1923; Franconia, August 2, 1930; Hill, July 23, 1923; Isles of Shoals, July 15, 1928, July 23–28, 1929; Lee, September 9, 1928, August 7, 1930; Portsmouth, September 3, 1922; Wonalancet, September 27, 1930. Common in grass in meadows.

Acucephalus albifrons (Linnaeus). Dover, July 19, 1922; Durham, August 6, 1900 (W. F. F.), July 21, September 1, 11, October 2, 1922, July 27, August 11, 1923, July 16, 1929, July 12, 1930; Hampton, July 16, 1930; Isles of Shoals, July 27, 1929; Mt. Washington, reported for alpine region (A. T. S., 1906); Rye, July 25, 1928; Waterville, October 2, 1898 (W. F. F.). Common in meadows.

Xestocephalus pulicarius Van Duzee. Durham, August 29, 30, September 8, 14, 1922; Newmarket, August 31, 1922; Nottingham, September 4, 1927; Portsmouth, September 3, 1922. Common in swampy meadows and grass along roadside.

Xestocephalus superbus (Provancher). Concord, August 12, 1929; Durham, August 29, September 21, October 2, 1922; Newmarket, August 31, 1922; Nottingham, September 4, 1927; Wonalancet, September 27, 1930.

Hecalus lineatus (Uhler). Durham, September 14, 1921, September 1, 1922, September 7, 1927; Hampton, July 16, 1930, from tall coarse grass at edge of salt marsh.

Parabolocratus viridis (Uhler). Reported for State in Van Duzee's Cat. Hem.

Parabolocratus major Osborn. Hill, June 23, 27, 1923, from meadow.

Parabolocratus flavidus Signoret. Durham, September 13, 15, 1924 (Det. E. D. B.), August 18, 1927.

Aligia modesta (Osborn and Ball). Durham, September 6, 1924 (Det. E. D. B.). Pitch pine barren.

Mesamia vitellina (Fitch). Durham, September 4, 1897 (W. F. F.), August 1, 1898 (W. F. F.), July 11, 14, September 8, October 2, 1922, July 1, 1923; Hill, July 23, 1923; Isles of Shoals, July 26, 1929; Lee, August 12, 1930; reported for State (Slosson—coll.) (E. D. B., 1907); Nottingham, September 4, 1927; Raymond, July 13, 1930. From shrubs.

Scaphoideus auronitens Provancher. Durham, July 24, September 13, 15, 16, 22, 30, 1921, August 27, 30, September 8, 25, October 14, 1922. A common species on undergrowth in open woods.

Scaphoideus jucundus Uhler. Durham, September 21, 1922, August 28, 1924; Ossipee, September 17, 1927 (Det. E. D. B.). Swept from bushes along roadside.

Scaphoideus scalaris Van Duzee. Durham, August 27, 29, 30, September 14, 23, October 2, 14, 1922; Newmarket, August 31, 1922; Mt. Washington, recorded for alpine region (A. T. S., 1902).

Scaphoideus lobatus Van Duzee. Durham, September 15, 1921, October 2, 1922; Portsmouth, September 3, 1922; Mt. Washington, reported for alpine region (A. T. S., 1902).

Scaphoideus ochraceus Osborn. Recorded for State in V. D. Cat. Hem.; Durham, record (H. O., 1911).

Scaphoideus productus Osborn. Lee, August 12, 1930; Raymond, July 14, 1930; Rochester, July 10, 1930; Wonalancet, July 17, 1930. In heath-shrub association.

Scaphoideus carinatus Osborn. Hanover, one female used in original description (H. O., 1900); Center Harbor, September 10, 1914 (C. W. J.); Jackson, September 18, 1927. From shrubs at edge of woods or along road.

Scaphoideus intricatus Uhler. Franconia (A. T. S.), reported (H. O., 1911).

Scaphoideus immistus (Say). Dublin, August 20; Mt. Washington, reported for alpine region (A. T. S., 1902); Pinkham Notch, Glen House, July 15, 1915 (C. W. J.); Wonalancet, July 17, 1930. Common.

Scaphoideus immistus var. *minor* Osborn. Durham, August 29, 1922, from white pine.

Scaphoideus melanotus Osborn. Durham, July 11, 1922.

Platymetopius acutus (Say). An abundant species in the State on grass in meadows, pastures, swamps, on sedges, blueberry, ferns, willow, dogwood, etc.

Platymetopius cuprescens Osborn. Twin Mountain, July 28, 1900 (W. F. F.).

Platymetopius angustatus Osborn. Durham, September 6, 15, 1924, August 18, 1928; Madbury, September 5, 1927; Nottingham, September 4, 1927; Lee, August 18, 1927; Ossipee, September 17, 1927. Common on pitch and red pine.

Platymetopius fulvus Osborn. Durham, September 16, 1921, August 30, September 23, 1922, September 19, 1924. On blueberry.

Platymetopius frontalis Van Duzee. Webster, August 4, 1898 (W. F. F.).

Platymetopius magdalensis Provancher. Durham, July 14, August 29, September 7, 8, 21, 23, 1922, July 1, 18, August 11, 1923; Hill, July 23, 1923; Lee, August 12, 1930; Raymond, July 13, 1930; Rochester, July 10, 1930; Wonalancet, July 17, 1930. Common on blueberry.

Platymetopius magdalensis var. *cinnamoneus* Osborn. Concord, August 12, 1929; Durham, August 29, 30, September 8, 23, 1922, July 1, 1923; Rochester, July 10, 1930; Wonalancet, July 17, 1930. Common on blueberry.

Flexamia sandersi (Osborn). Durham, August 29, September 8, 21, October 2, 1922, July 1, 1923, August 28, September 6, 1924; Farmington, July 6, 1923, October 2, 1924; Lee, August 7, 1930; Newmarket, August 31, 1922; Rochester, July 10, 1930. Common on Andropogon.

Flexamia delector (Sanders and DeLong). Durham, July 14, 1922, July 18, 1923, from short, fine grass in shady woods, August 11, 1923. (Weed—coll.) Reported by D. M. DeLong, 1926. The species referred to by Osborn and Ball as *D. bilineatus* G. & B., "collected in N. H. by Professor Weed" (1897) probably refers to this species; as does also the specimen called *D. productus* Walk. by Osborn (1915), collected at Hanover (C. M. W.).

Latulus configuratus (Uhler). Durham, June 1, 2, July 5, 18, 1923, May 22, 1925; Farmington, July 6, 1923; Franconia, August 2, 1930; Hill, July 23, 1923; Lee, June 28, 1928; Mt. Washington, reported from alpine region by A. T. S., 1894, July 4, 1914 (C. W. J.); Webster, July 18, 1900; White Mountains, July 30, 1900 (W. F. F.); Wonalancet, June 20, 1930. Common in dry areas on Andropogon.

Latulus sayi (Fitch). A common species of meadows and pastures.

Latulus misellus (Ball). Found in most places where collecting was done. Common in meadows and sterile pastures.

Polyamia obtecta (Osborn and Ball). Durham, September 21, 23, 1922, July 18, September 11, 1923; Rumney, September 28, 1927. From dry upland pasture and from dry meadow.

Polyamia compacta (Osborn and Ball). Durham, July 17, September 11, 23, 1922, July 1, 18, 1923, September 15, 1924; Hill, July 23, 1923. Taken in dry pastures.

Polyamia apicata (Osborn). Durham, September 8, 1921, July 11, 14, 17, September 8, 11, 1922, July 1, 5, 18, 1923; Webster, July 18, 1900 (W. F. F.). Taken in dry pastures.

Polyamia caperata (Ball).—(*vinnulus* Crumb). Durham, September 15, 1924, on Andropogon in sandy pitch pine area.

Polyamia inimica (Say). Common throughout the state in meadows and pastures.

Laevicephalus melsheimerii (Fitch). Durham, July 7, 20, August 30, September 7, 8, 25, 28, 1922, July 1, 5, 18, September 11, 1923; Farmington, July 6, 1923; Hill, July 23, 1923; Lee, June 28, 1928; Mt. Washington, reported for alpine region (A. T. S., 1898); Wonolanset, June 20, 1930. A common species in dry pastures.

Laevicephalus unicoloratus Gillette and Baker. (*oculatus* O. & B., *nominatus* S. & DeL.). Durham, September 1, 21, 1922, July 2, 5, 1923, June 13, 1930; Farmington, July 6, 1923, October 2, 1927; New Hampshire, recorded by D. M. D., 1926; Newmarket, August 31, 1922; Webster, August 4, 1898 (W. F. F.). From dry pastures.

Laevicephalus sylvestris (Osborn and Ball). Durham, September 21, 1922, August 11, 1923; Fabyans, July 24, 1900 (W. F. F.); Rochester, July 10, 1930; White Mountains, July 30, 1900, from summit Mt. Clinton (W. F. F.).

Laevicephalus acus (Sanders and DeLong). Concord, August 12, 1929; Durham, August 29, September 8, 1922, July 1, August 11, 1923; Franconia, August 2, 1930; Hill, July 23, 1923; Isles of Shoals, July 23–28, 1927; Nottingham, September 4, 1927. Common in dry upland pastures.

Laevicephalus pascuellus (Fallen). Durham, September 8–October 3, 1921, July 7–October 28, 1922, June 23, 1923, September 1, 1924, August 15, 1926; Fabyans, September 2, 1928; Mt. Washington, reported for alpine region (A. T. S., 1906); North Hampton, September 13, 1922; Portsmouth, September 3, 1922; Rye, June 30, 1928; Wonolanset, June 20, 1930. Common in meadows, pastures, and swampy areas.

Laevicephalus abdominalis (Fabricius). Reported for State (D. M. D., 1926); Twin Mountain, July 28, 1900 (W. F. F.).

Laevicephalus debilis (Uhler). Fabyans, July 24, 1900 (W. F. F.); reported from State (D. M. D., 1926); Twin Mountain, July 28, 1900 (W. F. F.).

Laevicephalus littoralis (Ball). Durham, September 7, 1927. In salt marsh.

Laevicephalus striatus (Linnaeus), (*affinis* G. & B.). Durham, June 5, 1922, September 23, 1922; Isles of Shoals, July 23–28, 1929; White Mountains, July 26, 30, 31, 1900, from summit of Mt. Clinton (W. F. F.).

Amplicephalus simplex (Van Duzee). Durham, September 1, 1924. From *Spartina*, salt marsh.

Deltocephalus flavicostus (Stal). Durham, July 18, 1923, swept from dry hilltop pasture, closely grazed.

Deltocephalus pulicarius (Fallen). Mt. Washington (base), September 7, 1920 (L. W. S.).

Deltocephalus balli Van Duzee, September 23, 1922.

Aconura acuticauda (Baker). Durham, July 17, 20, September 8, 1922, May 17, July 1, 18, 1923, September 6, 15, 1924; Farmington, July 6, 1923; Hill, July 23, 1923; Webster, July 18, 1900 (W. F. F.); Wonolanset, June 20, 1930. Common in dry sandy pastures.

Driotura gammaroides (Van Duzee). Durham, September 1, 1922, July 18, 1923, May 22, July 6, 1925; Lee, August 7, 1930. Common in pasture.

Drylix striolus (Fallen). North Hampton, July 16, 1930. Common in salt marsh among grasses and sedges.

Euscelis extrusus (Van Duzee). Reported for State (O. & B., 1902); Hanover, July 8, 1908 (C. W. J.); Mt. Washington (near base), July 24, 1900 (W. F. F.).

Euscelis alpinus (Ball). Recorded for State in Van Duzee's Cat. Hem.

Euscelis obsoletus (Kirschbaum)—Ball says: *deceptus* S. & DeL. = *relativus* G. & B. = *obsoletus* Kirschbaum. Mt. Washington (base), September 7, 1920 (L. W. S.).

Ophiola uhleri (Ball). Durham, August 1, 1898, swept from goldenrod (W. F. F.), June 28, 1900, from trap lantern (W. F. F.), July 18, 1923; Hanover, July 28, 1892 (C. M. W.), July 8, 1908 (C. W. J.); reported for State (O. & B., 1902).

Ophiola anthracina (Van D.). Hanover, July 8, 1908 (C. W. J.).

Ophiola cuneata (Sanders and DeLong). Durham, September 8, 22, 1921, July 7–October 2, 1922, July 1, 9, 1923; Hill, July 23, 1923; North Hampton, September 13, 1922; Portsmouth, September 3, 1922; Lee, August 7, 1930. Common in wet meadows.

Ophiola arctostaphyli (Ball). Mt. Washington, reported for alpine region (A. T. S., 1902), (O. & B., 1902), September 3, 1925, 6,200 ft. (Det. E. D. B.).

Ophiola humida (Osborn). Durham, September 23, 1922, August 28, September 4, 19, 1924; Jackson, September 18, 1927, (Det. E. D. B.). From bog shrubs.

Ophiola striatula (Fallen). Durham, September 23, 1922, July 1, 1923, August 28, September 4, 19, 1924; Isles of Shoals, July 23–28, 1929. Common in boggy areas.

Ophiola comptoniana Ball. Durham, September 10, 1921, September 21, 23, 1922, July 18, September 11, 1923; Lee, August 12, 1930; Madbury, September 5, 1927; Ossipee, September 17, 1927; Rochester, July 10, 1930; Webster, August 4, 1898 (W. F. F.); Wonalancet, July 17, 1930. Common in heath-shrub association.

Ophiola osborni Ball. Durham, July 17, 1922, July 5, 1923, July 21, 1930; Jackson, September 18, 1927; Lee, August 7, 1930; Wonalancet, July 17, 1930. Common in dry shrubby area.

Ophiola angustata (Osborn). Mt. Washington, September 3, 1925, 6,200 ft. (May not this also be *plutonia?*)

Ophiola cornicula (Marshall). Mt. Washington, September 3, 1925, 6,200 ft.

Commellus comma (Van Duzee). Mt. Washington, reported for alpine region (A. T. S., 1902); reported for State (O. & B., 1902); Webster, July 18, 1900, in dry stubble field (W. F. F.).

Amblysellus curtisii (Fitch). Reported for State (O. & B., 1902); Durham, September 1, 1897 (W. F. F.), October 15, 1898 (W. F. F.), June 27, 1900 (R. A. C.), September 8, 26, 1921, July 7–October 3, 1922, June 23, July 5, 1923; Hanover, August 18, 1892 (C. M. W.); Haverhill, October 7, 1927; Waterville, October 2, 1898 (W. F. F.); Webster, August 1, 1898 (W. F. F.); White Mountains, July 31, 1900 (W. F. F.).

Eutettix luridus (Van Duzee). Durham, September 14, 21, 1922 (Det. E. D. B.). From oak.

Eutettix marmoratus (Van Duzee). Durham, September 15, 1921, August 30, 1922 (Det. E. D. B.); Ossipee, September 17, 1927 (Det. E. D. B.).

Eutettix southwicki Van Duzee. Ossipee, September 17, 1927, common on scrub oak on dry sandy hillside (Det. E. D. B.).

Eutettix johnsoni (Van Duzee). Alton, August 19, 1928; Durham, September 16, 1921, October 5, 1922, August 18, 1928; reported for state (Weed—coll.) (E. D. B., 1907); Nottingham, September 4, 1927; Webster, July 21, 1900 (W. F. F.); Wonalancet, July 17, 1930. Taken in damp forest or woods.

Eutettix seminudus (Say). Durham, July 11, 1922.

Eutettix cinctus Osborn and Ball. Durham, August 30, September 21, 1922, September 15, 1924; Newmarket, August 31, 1922. From scrub white oak at edge of woods.

Phlepsius graniticus Osborn and Lathrop. Durham, September 21, 1922, September 6, 15, 1924, August 18, 1927; Lee, September. From pitch and red pine.

Phlepsius fuscipennis Van Duzee. Durham, July 21, 1897, from salt marsh (W. F. F.).

Phlepsius collitus Ball. Durham, July 11, 1898 (W. F. F.), September 8, 1921, July 7, August 30, September 1, October 5; Hill, July 23, 1923. From willow and blueberry.

Phlepsius irroratus (Say). Common on grass in meadows, pastures; taken on willow and *cornus*.

Phlepsius apertus Van Duzee. Jefferson, September 18, 1927. From roadside grass.

Phlepsius carolinus Lathrop. Durham, August 29, September 21, 1922, September 13, 15, 1924, August 18, 1928; Farmington, October 2, 1927. From blueberry, pitch pine, Andropogon, etc.

Phlepsius fulvidorsum (Fitch). Durham, August 18, 1899 (R. A. C.), July 17–October 3, 1922, July 1, 1923; Franconia, August 2, 1930; Hill, July 23, 1923; Lee, September 9, 1928, August 7, 1930; Littleton, September 9, 1895 (C. M. W.); Nottingham, September 4, 1927; Portsmouth, September 3, 1922; Rochester, July 10, 1930; Webster, August 4, 1898 (W. F. F.).

Phlepsius tullahomi DeLong—*slossoni* var. *fastuosus* Ball (1927). Durham, September 13, 1921, September 6, 13, 15, 1924; Farmington, July 6, 1923; Webster, July 21, 1900 (W. F. F.). From birch, Andropogon, pitch pine barren, etc.

Phlepsius franconianus Ball—*P. strobi* (1927). Described (E. D. B., 1903) from male from Franconia collected (A. T. S.).

Phlepsius strobi (Fitch). Durham, July 3, 1924. From white pine (Det. E. D. B.).

Phlepsius nebulosus Van D. Durham, (H. O., 1905).

Phlepsius solidaginis (Walker). Durham, September 22, 1921, August 29, September 7, 11, 1922. From swamp grass.

Phlepsius ramosus Baker. Durham, July 7, 1899, in trap lantern (W. F. F.), September 1, 1924, September 7, 1927 (Det. E. D. B.). From salt marsh.

Phlepsius bifidus Sanders and DeLong. Portsmouth, September 3, 1922, from wet, bushy pasture.

Phlepsius decorus Osborn and Ball. Newmarket, August 31, 1922, from grass in open woods.

Acinopterus acuminatus Van Duzee. Durham, August 29, 1922, September 6, 13, 15, 1924, August 18, 1927, August 18, 1928; Nottingham, September 4, 1925. From pitch pine barren.

Thamnotettix kennicotti (Uhler). Durham, July 11, 1898 (W. F. F.), July 23, 1921, July 14–October 14, 1922, July 18, 1923; Mt. Washington, reported (A. T. S., 1895) alpine region; Lee, August 7, 1930; Rochester, July 10, 1930. From birch, Cornus, pitch pine and in low bushy pastures and meadows.

Thamnotettix subcupraeus (Provancher). Reported for State in Van Duzee's Cat. Hem.

Thamnotettix morsei Osborn. Durham, September 16, 1921, August 30, September 7, 23, 25, 1922. Swept from shrubs.

Thamnotettix clitellarius (Say). Durham, September 4, 1897 (W. F. F.), July 6–7, 1899 (R. A. C.), June 22, 28, 1900, in trap lantern (W. F. F.), June 27, 29, July 2, 1900 (R. A. C.), September 13–14, 1921, October 5, 1922, July 5, 9, 1923; June 27, 1924; Fabyans, September 2, 1928; Dover, July 19, 1922; Hill, July 23, 1923; Lee, August 7, 1930; Rye, July 6, 1928. From grass and bushes.

Thamnotettix eburatus Van Duzee. Mt. Washington (base), September 7, 1920 (L. W. S.).

Thamnotettix belli (Uhler). Durham, May 12, June 12, 24, 1925. Swept from underbrush in opening in white pine-hemlock woods.

Thamnotettix belli var. *brunneus* Osborn. Durham, July 8, 1922. Swept from bushes.

Thamnotettix n. sp. (Near *perspicillatus* O. & B., sent to and retained by E. D. B.; I called this *Eutettix auratus* Ball). Durham, September 21, 1922, September 6, 15, 1924. From pitch pine.

Thamnotettix chlamydatus (Provancher). Bretton Woods, July 27, 1913 (C. W. J.); Glen House, Pinkham Notch, July 15, 1915 (C. W. J.); Mt. Washington, Halfway House, July 4, 1914 (C. W. J.), 2,500 ft. (C. W. J.); White Mountains, July 24, 1900 (W. F. F.), near base of Mt. Washington.

Thamnotettix melanogaster (Provancher). Durham, October 15, 1898 (W. F. F.), September 8–26, 1921, July 7–October 2. Common in low wet pastures and meadows, July 1, 9, August 1, 1923; Lee, August 7, 1930. In tall swamp grass.

Thamnotettix decipiens Provancher. Durham, September 20, 1922, September 19, 1924, September 7, 1927. From low meadow, sedge, edge of salt marsh.

Thamnotettix smithi Van Duzee. Durham, September 21, 1922; Webster, July 17, 1900. From damp meadow.

Thamnotettix fitchii Van Duzee. Durham, September 1, 1924, from tall grass at tide mark in salt marsh.

Thamnotettix inornatus Van Duzee. Alton, October 2, 1927; Durham, September 13, 26, 1921, August 29–October 5, 1922; Fabyans, September 2, 1928; Haverhill, October 7, 1927; Lee, August 7, 1930. Common on tall grass in swamp, or in low wet meadows.

Chlorotettix unicolor (Fitch). Common in meadows, pastures and on swamp grasses.

Chlorotettix spatulatus Osborn and Ball. Durham, August 15, 16, 1899, August 29, 1922; Concord, August 12, 1929; Lee, August 7, 1930. From tall grass in swampy region.

Chlorotettix tergatus (Fitch). Durham, August 1, 1898 (W. F. F.), August 18, 1899 (R. A. C.), August 6, 1900 (W. F. F.), September 8–30, 1921, August 29–September 14, 1922, August 11, 1923; Lee, August 7, 1930. From coarse grass in low meadows, pastures, swamps, along streams.

Chlorotettix galbanatus Van Duzee. Durham, August 30, 1922, July 1, 1923; reported for White Mountains—Fiske.

Chlorotettix balli Osborn. Durham, July 17, 20, August 30, 1922, August 11, 1923, August 28, 1924, July 31, 1925.

Chlorotettix lusorius (Osborn and Ball). Durham, October 14, 1922; Mt. Washington, reported (A. T. S., 1906) for alpine region.

Jassus olitorius Say. Center Harbor, September 10, 1914 (C. W. J.); Barrington, August 22, 1897 (C. M. W.); Durham, August 1, 1898 (W. F. F.), July 29, August 9, 15, 1899 (R. A. C.), July 19, September 14, 1921, August 27, 29, 30, September 25, 1922, August 11, 1923; Exeter, August 10, 1927; Lee, August 7, 1930; Wilton, August 22, 1928. On grape, corn, shrubs.

Paracoelidea tuberculata Baker. Durham, September, 1899 (W. F. F.), August 30, 1922, September 21, 1922, September 6, 15, 1924, August 18, 1927; Newmarket, August 31, 1922. Common on pitch pine.

Cicadula punctifrons var. *repleta* Fieber. Hanover, July 21, 1892 C. M. W.), July 6, 1908 (C. W. J.); Mt. Washington, reported for alpine region (A. T. S., 1897, 1902).

Cicadula variata (Fallen). Durham, June 28, 1900 (W. F. F.); Mt. Washington, near base, July 24, 1900 (W. F. F.); reported for alpine region (A. T. S., 1896).

Cicadula lepida Van Duzee. Durham, July 17, 1898 (W. F. F.), September 13, 1921, July 7–October 2, 1922, June 25, September 11, 1923; Nottingham, September 4, 1927. On *Impatiens*.

Cicadula sexnotata (Fallen). Common in meadows and pastures everywhere.

Cicadula pallida Osborn. Durham, September 23, 1922, June 28, September 4, 19, 1924; Spruce Hole, June 13, 1930. From bog herbs.

Cicadula divisa (Uhler). Mt. Washington, reported for alpine region (A. T. S., 1902).

Cicadula slossoni Van Duzee. Durham, September 8, 1921, July 8–October 2, 1922, July 9, 27, 1923; Mt. Washington, reported for alpine region (A. T. S., 1894), 6,200 ft., September 3, 1925; New Durham, October 2, 1927; Newmarket, August 31, 1922; North Hampton, September 13, 1922; Wonalancet, July 1, 1930. Common on *Juncus*.

Balclutha punctata (Thunberg). Common on grasses in meadows and pastures; also from grass in moist wood and from bog-herb zone.

Balclutha osborni Van Duzee. Mt. Clinton (near summit), July 31, 1900 (W. F. F.); White Mountains, from alpine summits of presidential range, July 26–28, 1900 (W. F. F.).

Balclutha impicta (Van Duzee). Durham, July 14–August 30, 1922, June 23, August 11, 1923; Hill, July 23, 1923; Mt. Clinton, near summit, July 30, 1900.

Eugnathodus abdominalis (Van Duzee). Dixville, September 9, 1930; Durham, September 16, 1921, July 14, September 7, 14, 1922; Hill, July 23, 1923; Isles of Shoals, July 22–28, 1929; Mt. Washington (near base), July 24, 1900 (W. F. F.); Raymond, July 13, 1930; Twin Mountain, July 28, 1900 (W. F. F.); Wonalancet, July 17, 1930, September 27, 1930.

Alebra albostriella var. *agresta* McAtee. Durham, July 14, 1922, August 11, 1923. From white oak (Det. W. L. M.).

Alebra albostriella var. *fulveola* (Herrick-Schaeffer). Durham, August 11, 1923, on white oak.

Dikraneura mali (Provancher). Chocorua Lake, September 1, 1928; Dixville, September 9, 1930; Durham, September 14, 22, October 3, 1921, June 5, July 11, 21, August 29, September 1, 8, 21, October 2, 1922, May 7, August 11, 1923; Lee, August 12, 1930; White Mountains, alpine summits, July 28, 1900 (W. F. F.).

Dikraneura fieberi (Loew). Common in meadows and pastures.

Dikrancura abnormis var. *urbana* Ball and DeLong. Durham, July 18, 20, 21, 1922, August 30, September 18, 1922; Hill, July 23, 1923; Newmarket, August 31, 1922; Wonalancet, July 17, 1930. Fairly common in moist meadow.

Empoasca maligna (Walsh). (*unicolor* (Gillette)). Apple Leafhopper. Durham, July 14, 20, 1922; Hill, July 23, 1923. On apple.

Empoasca smaragdula (Fallen). Durham, August 18, 1923, on willow.

Empoasca obtusa Walsh. Durham, September 14, 21, 1922, July 9, 1923; Mt. Washington, reported for alpine region (A. T. S., 1902).

Empoasca unica (Provancher). Durham, June 28, 1900, in trap lantern (W. F. F.), September 8, 22, 1921, July 7, August 30, 1922; Epping, June 27, 1898 (W. F. F.); Portsmouth, September 3, 1922; Webster, July 17–19, 1900 (W. F. F.). Common on alder.

Empoasca atrolabes Gillette. Durham, July 15, 17, 1898 (W. F. F.), August 29, 30, 1922, September 8, 1922, July 1, 1923; White Mountains, near base of Mt. Washington, July 24, 1900 (W. F. F.); Wonalancet, July 17, 1930. Common on alder.

Empoasca sp. (McAtee). Durham, September 22, 1921, August 30, September 21, 1922, July 18, 1923; Jackson, September 18, 1927. In dry bushy pastures.

Empoasca pergandei Gillette. Durham, September 14, 1921, July 18, 1923, September 7, 1927. On black locust. (Det. W. L. M.).

Empoasca coccinea (Fitch). Common on white and pitch pine.

Empoasca fabae (Harris). (*mali* (LeBaron)). Potato Leafhopper. Exeter, July 30, 1926; Lancaster, August 18, 1927; Madbury, September 8, 1927; Manchester, August 20, 1928. Potato.

Empoasca birdii Goding. Alton, October 2, 1927; Chocorua Lake, September 1, 1928; Durham, September 14, 1921, August 30, September 1, 7, 20, 25, October 14, 1922, May 9, 16, 20, 1925; Wonalancet, July 17, 1930.

Eupteryx melissae Curtis. Durham, July 9, 1925; Wilton, October 22, 1927. Common on catnip.

Eupteryx vanduzei Gillette. Durham, June 20, 1925; Hanover, July 8, 1908 (C. W. J.). Swept from ferns in white pine-hemlock forest.

Eupteryx flavoscuta var. *flavoscuta* Gillette. Chocorua Lake, September 1, 1928; Durham, September 30, 1921, August 29, October 14, 1922, June 12, 1925; Dixville, September 9, 1930; Hill, July 23, 1923; Holderness, reported (C. P. G., 1898); Mt. Washington (2,500 ft.), July 28, 1915. Common on ferns in white pine woods.

Eupteryx flavoscuta var. *juvenis* McAtee. Newmarket, August 31, 1922.

Eupteryx flavoscuta var. *clavalis* McAtee. Durham, September 30, 1921, July 14, 1922. From common wood fern.

Eupteryx flavoscuta var. *nigra* Osborn. Dixville, September 9, 1930; Durham, September 30, 1921, July 14, September 25, 1922; Hanover, July 8, 1908 (C. W. J.). From wood ferns.

Typhlocyba tenerrima Herrick-Schaeffer. Mt. Washington, reported for alpine region (A. T. S., 1898), (W. L. M., 1926—"has been unable to verify the reported occurrence of this species in America"). This is probably *T. unca* McA.

Typhlocyba piscator McAtee. Durham, June 23, 1923, (Det. W. L. M.).

Typhlocyba unca McAtee. Alton, October 2, 1927; Durham, September 8, 22, 30, 1921, August 30, September 7, 21, 1922, September 9, 1927 (Det. W. L. M.); Hill, July 23, 1923; Jackson, September 18, 1927; Mt. Washington (E. D. B.), male holotype (W. L. M., 1926). Common on alder.

Typhlocyba rosae (Linnaeus). Colebrook, September 9, 1930; Durham, September 13, 14, 15, 22, 1921, July 14, August 29, September 1, 11, 14, September 11, 13, 1923, August 20, October 3, 1924, September 25, 1925, September 7, 1927; Portsmouth, September 3, 1922. Common on roses, *Spiraea*, etc.; badly spotting apple leaves.

Typhlocyba lethierryi Edwards. Durham, September 9, 1927, (Det. W. L. M.).

Typhlocyba lancifer McAtee. Durham, July 5, 1923, from sugar maple, (Det. W. L. M.).

Typhlocyba cymba var. *cymba* McAtee. Alton Bay, July 27, 1930, in spider's web.

Typhlocyba cymba var. *pallens* McAtee. Chocorua Lake, September 1, 1928; Franconia, August 2, 1930, from red maple.

Typhlocyba cymba var. *unipuncta* McAtee. Jackson, September 18, 1927, (Det. W. L. M.).

Typhlocyba cymba var. *grata* McAtee. Mt. Washington (E. D. B.), recorded (W. L. M., 1926); Wonalancet, July 17, 1920.

Typhlocyba gillettei var. *gillettei* Van Duzee. Durham, July 17, 1898 (W. F. F.), July 5, 1899, at light (W. F. F.), June 21, 1900, from light (W. F. F.), September 30, 1921, July 14, September 7, (Det. (W. L. M.), 1922, August 11, 1923, September 9, 1927; Glen to Halfway House, White Mountains, July 8, 1891 (U. S. N. M.); Mt. Washington, reported for alpine region (A. T. S., 1896), (E. D. B., U. S. N. M.) and Waterville, July 17, 1906 (W. L. M., 1926); Nottingham, September 4, 1927; Ossipee, July 11, 1929. Fairly common on white oak and alders nearby.

Typhlocyba gillettei var. *suffrana* McAtee. Mt. Washington (E. D. B.), male holotype described from this locality (W. L. M., 1926).

Typhlocyba gillettei var. *casta* McAtee. Nottingham, September 4, 1927.

Typhlocyba gillettei var. *venusta* McAtee. Fabyans, September 2, 1928. From alder.

Typhlocyba pomaria McAtee. Durham, August 27, 1922, (Det. W. L. M.), August 21, 1924, (Det. W. L. M.), October 24, 1927, adults fairly common on apple; leaves show considerable white stippling; Wilton, August 11, September 30, October 22, 1927. Common on apple.

Typhlocyba arsinoe McAtee. Durham, August 30, 1922, (Det. W. L. M.).

Typhlocyba nitidula Fabricius. Mt. Washington, reported for alpine region (A. T. S., 1906). (W. L. M., 1926—"in the present study no species of the true *nitidula* has been found, and it is suggested that the Slosson record may be based on one of the varieties of *T. gillettei* or *T. cymba*.")

Typhlocyba modesta Gibson. Alton, October 2, 1927, (Det. W. L. M.); Jackson, September 18, 1927, (Det. W. L. M.).

Erythroneura vulnerata var. *vulnerata* Fitch. Durham, September 26, 1921, August 29, September 20, 1922, July 18, 1923, (Det. W. L. M.), September 13, 1923. On woodbine, grape.

Erythroneura niger (Gillette). Durham, May 7, 1923.

Erythroneura obliqua (Say). Common on underbrush in woods.

Erythroneura obliqua var. *eluta* McAtee. Durham, August 30, 1922.

Erythroneura obliqua var. *dorsalis* (Gillette). Durham, September 13, 14, 1921, (Det. W. L. M.), August 30, September 25, 1922. Taken from underbrush.

Erythroneura obliqua var. *stolata* McAtee. Durham, September 16, 1921, September 21, 25, October 14, 1922, (Det. W. L. M.).

Erythroneura obliqua var. *parma* McAtee. Durham, September 25, 1922, March 23, 1924, (Det. W. L. M.); Rochester, July 10, 1930, on blueberry.

Erythroneura obliqua var. *noevus* (Gillette). Durham, September 1, 1922, September 19, 1924.

Erythroneura obliqua var. *fumida* (Gillette). Durham, September 25, August 30, October 14, 1922, (Det. W. L. M.), September 19, 1924, May 12, 1925, (Det. W. L. M.).

Erythroneura obliqua var. near *clavata* DeLong. Durham, September 8, 23, 1922, August 28, September 4, 1924. Swept from bog shrubs where *Kalmia angustifolia* was dominant shrub.

Erythroneura abolla var. *varia* McAtee. Durham, September 14, 1921, (Det. W. L. M.), August 27, September 17, 1922, (Det. W. L. M.), September 7, 1927, (Det. W. L. M.). One yellow form from elm.

Erythroneura abolla var. new. Durham, September 16, 1921, August 30, 1922, May 12, 16, 1925; Mt. Washington, July 24, 1925, 2,500 ft. (C. W. J.).

Erythroneura tecta var. *carbonata* McA. Durham, September 22, 1921, (Det. W. L. M.), September 7, 11, 1922, (Det. W. L. M.).

Erythroneura scutelleris (Gillette). Durham, September 7, 1927, from American elm, (Det. W. L. M.).

Erythroneura basilaris var. *basilaris* (Say). Durham, September 8, 1922, (Det. W. L. M.).

Erythroneura maculata var. *maculata* (Gillette). Common on underbrush.

Erythroneura maculata var. *bigemini* McAtee. Durham, July 9, 1923, on willow.

Erythroneura maculata var. *gemina* McAtee. Durham, September 13, 14, 1921, July 8, October 2, 1922, August 21, 1924, (Det. W. L. M.); Dixville, September 9, 1930. Common on field and roadside shrubs.

Erythroneura vitis var. *vitis* (Harris). Durham, August 29, September 11, 1923, (Det. W. L. M.), September 13, 1923, on grape.

Erythroneura tricincta var. *tricincta* Fitch. Mt. Washington, reported for alpine region, (A. T. S., 1902).

Erythroneura comes var. *comes* (Say). Durham, September 3, 16, 1921, August 29, September 11, 1922, September 13, 1923; Wilton, October 22, 1927. Common on grape.

Erythroneura comes var. *vitifex* Fitch. Alton, October 2, 1927, (Det. W. L. M.); Durham, September 8, 1923, (Det. W. L. M.), June 12, 1925. On blueberry and shrubs.

Erythroneura comes var. *elegans* McAtee. Durham, September 26, 14, 1921, (Det. W. L. M.), July 18, 1923. Common on woodbine.

Erythroneura comes var. *ziczac* Walsh. Durham, September 26, 1921. From woodbine.

Erythroneura comes var. *rubra* (Gillette). Durham, September 7, 1922, June 24, 1925, September 13, 1923, on grape; Pinkham Notch, Glen House, June 11, 1916 (C. W. J.).

Erythroneura comes var. *rubrella* McAtee. Durham, September 14, 15, 16, 1921, August 27, September 1, 7, 14, 20, 1922, May 7, August 11, 1923, (Det. W. L. M.), September 29, 1927, on *Cornus*, (Det. W. L. M.); Rochester, July 10, 1930, on blueberry.

Erythroneura comes var. *nudata* McAtee. Durham, September 13, 1923, on grape associated with var. *comes*.

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NOTICE.

The Ohio Journal of Science would like to purchase several copies of the Volume XXII, Number 6 (April, 1922) issue of the Journal. The Journal will pay $1.00 per copy for single numbers of this issue, in good condition. All persons whose attention is attracted by this notice are urged to canvass their back files of the Journal for extra or unwanted copies of this number. The Journal will regard any offers in response to this notice as an accommodation, as they can be used to good advantage by the management. Replies to this notice should be addressed to the Business Manager.

BOOK NOTICES

Fossil Brachyopods.

This extremely important work, which was started to include all Paleozoic brachiopods but because of the very immensity of the subject has had to be confined as yet to the genera of the suborders Orthoidea and Pentameroidea, is divided into five parts with an introduction and an appendix. Part I concerns itself with definitions of Brachiopod terms, a most needed assemblage. Part II considers the morphogenesis or evolution of form. Part III is the morphology of the Orthoid shell. Part IV describes and discusses the genera of the suborder Orthoidea, which are divided into 3 superfamilies, 23 families, of which Finkelnburgiidae and Tropidoleptidae are new, 18 subfamilies, 97 genera including Pomatotrema Ulrich and Cooper, and Clinambon, both new. With these numerous genera are 9 species of which 6 are new. Part V considers the genera of the suborder Pentameroidea, which are divided into 2 superfamilies, 6 families, 2 subfamilies, and 31 genera. In this part we find the morphology, generic and evolutionary trends of the suborder considered. The appendix considers the superfamily Rhychonellacea with 2 genera.

This excellent memoir represents the type of work which is so much needed to clarify the superabundance of names which are always appearing. This represents a study of the cream of the material gathered by Schuchert during his long period in Paleontology. Some 20 tables show the authors conception of the evolution trends of the genera and obscure points are illustrated by the text-figures. The Plate A illustrates Brachiopod morphology and the other 29 plates containing about 825 figures are of various specimens and show the excellence of the material studied.

It is a book that should be available in all Paleontological Libraries. My only regret is that more genera could not be treated and we hope that at a future date the authors will be able to make additional studies of the rest of the Paleozoic Brachiopods.—Willard Berry.

Brachiopoda Genera of the Suborders Orthoidea and Pentameroidea, by Charles Schuchert and G. Arthur Cooper. Published as Memoir of the Peabody Museum of Natural History, Vol. IV, Part I, pp. i–xii, 1–270, Pls. A, 1–29, Tables 1–20, Text Figs. 1–36, 1932. Size 9½ x 12. $7.00.

Physical Geology.

This new text to replace that of Pirsson's should prove even more popular than the one it replaces. The manner of joint authorship in which each author handles that which lies most within his field coupled with careful editing makes for a text which does not unduly stress certain parts at the expense of other parts. The balance of the various chapters in amount and detail is excellent. Following each chapter is a list of "reading references" with a short evaluation of each. From the standpoint of illustrations this new text far surpasses the others. The illustrations are plentiful and well chosen. They are both half tones and line cuts of both the plane and block variety. The well selected use of aero photographs is to be commended on as they give the reader at a glance a comprehensive view of large areas. This is especially true in the case of glaciers and shore forms where land photographs fail to tell the entire story. An appendix on Minerals, one on Rocks and a third on Topographic maps should prove valuable as the student should have this information condensed in one place and not have to dig it out of several hundred pages of text.

This text appears to be easily "teachable" and is most certainly easily "readable."—W. Berry.

Text-book of Geology, by C. R. Longwell, A. Knopf, and R. F. Flint. Part I. Physical Geology. 514 pp., 341 fig. New York, John Wiley and Sons, 1932. $3.25.

Rocks.

The author has done more than write "a combined text and laboratory guide" in this book. In the first part he deals with various criteria and methods; part II is devoted to the petrography of igneous rocks (114 pages); part III to the petrology of igneous rocks (117 pages); part IV to petrography of sedimentary rocks (45 pages); part V to petrology of sedimentary rocks (45 pages); part VI to petrography of metamorphic rocks (35 pages); part VII to petrology of metamorphic rocks (68 pages); and part VIII to minerals and selected readings (62 pages). Other selected readings accompany each chapter.

Geologists and students should welcome this book. Between its covers the three great groups of rocks are dealt with in a manner yet to be improved upon. Geologists should feel extremely fortunate that a man of Grout's experience could find time to put into one book, in such an expert manner, the results of his years of research and study. Anything but the most enthusiastic terms fail to express the quality of this great contribution. The author and publishers are to be congratulated on the production of this superlative work.—E. W. BERRY.

Petrography and Petrology (A Textbook), by Frank F. Grout. 522 pp., 265 ill. New York, The McGraw-Hill Book Co., 1932. $5.00.

The Physiology of Bacteria.

This is the title of a recent book by Prof. Otto Rahn. The word bacteria is used by the author not in its narrow taxonomic sense, but to include the yeasts as well. In fact the physiology of the yeasts occupies a prominent place in the discussions. Following the Preface and Introduction, the book is divided into four main parts, with the following headings: Endogenous catabolism, Energy supply of the cell, Growth, and Mechanism of death. Each of the last three parts is subdivided into a number of sections. A practical feature is the brief summary at the end of each chapter. A great deal of experimental data, much of it from original investigations by the author, is presented in the form of tables and graphs. There are in all 42 figures and 133 tables. There is a subject index and an author index to the papers cited in the text, but no attempt at a comprehensive bibliography is made. This book contains much of both fact and theory which should prove of interest to plant and animal physiologists, as well as to bacteriologists.—B. S. MEYER.

Physiology of Bacteria, by Otto Rahn, xiv + 438 pp. Philadelphia, P. Blakiston's Son & Co., 1932.

Experimental Pharmacology.

This small volume is a laboratory manual for students taking a brief course in experimental pharmacology. The material covered has been carefully selected and the experiments developed so as to emphasize specific features in the field of drug action. All non-essentials have been eliminated and the methods simplified. In carrying out this simplification the author assumes that the students have already had previous experience and training in physiological studies and manipulation and are therefore familiar with basic routine procedures. On the other hand certain features of pharmacologic technique, such as the various methods of administration of drugs and the use of the hypodermic syringe are described and discussed.

The experiments are selected to illustrate the general action of the drug and frequently to emphasize certain general principles involved. In these instances certain features are specifically mentioned such as "pathological pharmacology," toxicological action, pharmacological analysis, types of anesthesia, absorption, excretion, as well as the fate of drugs in the body. Certain bio-assays such as illustrated by the U. S. P. assay for digitalis are also given as examples of specific problems.

Noteworthy features which may be mentioned are the questions asked under each experiment, the special tests given, and the numerous references to the current literature.

Another noteworthy feature is the chapter addressed to the student in which three features are emphasized:

(1) "The preparation of the mind as well as the materials."
(2) "The laboratory procedure."
(3) "The analysis and interpretation of results."

The text is to be highly commended as a laboratory guide in a general course.

C. A. DYE.

Experimental Pharmacology and Toxicology, by Henry G. Barbour, M. D. Philadelphia, Lea and Febiger, 1932.

More About Evolution.

The third edition of this work has just come from the press. Originally a book of selected readings, subsequent editions have approached nearer to the nature of the text. The present edition is very usable as a genetics and evolution text. While some chapters are still made up of selections from the writings of others, Newman himself has coordinated and unified them by the addition of chapters and sections from his own pen. Following an opening discussion of the historical background of the evolutionary theory, the specific evidences are carefully discussed. A considerable part of the book is given over to the mechanism of evolution, that is, genetics. A very clear discussion of eugenics and human heredity makes the book of especial value to today's student.—L. H. S.

Evolution, Genetics and Eugenics, by H. H. Newman. xxix + 620 pp. Chicago, the University of Chicago Press, 1932. $3.50.

Insects and Disease.

The rapid advance in knowledge concerning the relations of insects and other arthropods to human health and disease, together with the widely scattered literature, necessitate frequent summaries of the available facts. This volume is an excellent account of the modern conceptions of insects and disease, and will be indispensable to the physician and public health worker, as well as to the entomologist. The interested layman will find it readable and authentic. Many fine illustrations add to its value, and the extensive bibliography will be greatly appreciated. The newly-developed use of blowfly larvae in osteomyelitis is discussed, as well as other recent developments.—L. H. S.

Medical Entomology, by Robert Matheson. xii + 489 pp. Springfield, Illinois, Charles C. Thomas, 1932.

How We Grow.

Julian Huxley has written a most interesting account of growth and growth processes, which considerably reinforces the rather scanty foundation upon which many of our ideas of development have been built. Growth gradients are thoroughly discussed, and their widespread existence established. Especially illuminating are the application of gradients to the various morphologic variations of related groups, by means of Cartesian transformation. No biologist can afford to miss this book.—L. H. S.

Problems in Relative Growth, by Julian Huxley. xix + 276 pp. New York, The Dial Press, 1932.

Thinking Machines.

The cordial reception accorded the first edition of this work has necessitated a second edition, in which some corrections have been made and some new material added. The book is a delightful compendium of the mechanistic basis of human behavior, with a sound psychological and philosophical background. As such it merits the attention of all those interested in any phase of human biology.

—L. H. S.

The Thinking Machine, by C. Judson Herrick. xii + 374 pp. Chicago, The University of Chicago Press, 1932. $3.00.

Mammals, Good and Bad.

The literature on economic mammalogy has been scattered through such a wide range of publications that it is a pleasure to have it brought together under one cover. The present volume, although rather naively written, adequately summarizes the available information. The first part of the book is a general discussion of the varied ways in which mammals may affect human welfare. The second part is a systematic discussion, taking up in turn each order and family. This part will be of especial interest to the scientist. Not only is an excellent bibliography appended, but the particular page in question is cited in addition in footnotes. The binding and make-up are exceptionally fine.—L. H. S.

Economic Mammalogy, by J. Henderson and E. L. Craig. x + 397 pp. Springfield, Illinois, Charles C. Thomas, 1932.

Our Mineral Civilization.

Those who have come under the spell or influence of Technocracy (the machine age) will find in this little volume a wealth of interesting statistics. The book deals largely with the development and use of our mineral resources and the influence of the invention of modern machinery on the demand for certain metals or inorganic compounds. The presentation of this story of the rise in importance of our minerals is both entertaining and instructive. It has been written in a non-technical manner, but should be just as interesting to the scientist as to the layman.—WALLACE R. BRODE.

Our Mineral Civilization, by Thomas T. Read. 165 pp. Baltimore, The Williams and Wilkins Co., 1932. (One of the Century of Progress Series.)